REMEDIAL DESIGN WORK PLAN

for

SOUTH CAVALCADE SITE

HOUSTON, TEXAS

VOLUME II

prepared for

BEAZER EAST, INC.

MARCH 1992

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Remedial Design Work Plan for South Cavalcade Site

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TREATABILITY STUDY WORK PLAN
FOR PILOT-SCALE STUDIES
SOUTH CAVALCADE SITE
HOUSTON, TEXAS

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1.0 INTRODUCTION

Beazer East, Inc. (Beazer), the successor of Koppers Company Inc., is in the process of implementing a Record of Decision (ROD) issued for the South Cavalcade site, located in Houston, Texas. The South Cavalcade site is a former wood treating site which operated between 1910 and 1962. From 1962 to the present, various owners for light industrial purposes occupied the site.

The 66 acre site was placed on the National Priorities List in 1984 and in 1985 Koppers agreed to conduct a Remedial Investigation/Feasibility Study (RI/FS). In 1988, the RI/FS was completed and a ROD was issued in September of that same year.

A "Detailed Statement of Work for South Cavalcade Site" (SOW) was prepared for Beazer in May of 1990 by Bechtel Environmental, Inc. (Bechtel). The purpose of this SOW is to present the activities necessary to develop a remedial design for the selected alternatives.

The ROD requires soil remedial activities to consist of a combination of soil washing and in situ soil flushing with a possibility for subsequent in situ biodegradation should cleanup criteria not be attained. For groundwater, remediation will consist of pretreatment followed by filtration, activated carbon adsorption and subsequent reinjection to the soil flushing unit or surface water discharge to the Little Whiteoak Bayou.

A Remedial Design Work Plan has been prepared in accordance with a Consent Decree between Beazer and the EPA. The work plan presents the required activities necessary to obtain information and design the full-scale remedial action. The components of the Remedial Design Work Plan are as follows:

- Detailed Statement of Work (SOW),
- Sampling and Analysis Plan (SAP),

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- Quality Assurance Project Plan (QAPP),
- Site Health and Safety Plan (H&S), and
- Pilot Treatability Work Plan.

The objective of this document is to present a conceptual approach to the pilot treatability work required to finalize the remedial design, and to describe the data that must be collected prior to final design of the pilot study. Currently, there is not enough site-specific data available to provide detailed designs of the pilot treatment systems. The Pilot Treatability Work Plan describes the treatment processes, additional data requirements, and procedures for design, construction, and operation of pilot-scale treatability tests. The pilot-scale test will be conducted to obtain data to verify attainment of cleanup goals using the selected remedies and to obtain information for full scale design. The following are the specific pilot tests that are included in the Pilot Treatability Work Plan. It should be noted that the groundwater extraction well pilot test is described in the SAP and is beyond the scope of this document.

Trench Drain/Soil Flushing Pilot Test

As part of groundwater recovery pilot tests being performed to obtain design information for an extraction/injection system, a trench drain/soil flushing pilot test will be conducted. This pilot test will provide design information on soil remediation by collecting and introducing flushing waters, and evaluate the efficiency of surfactants to solubilize polynuclear aromatic hydrocarbons (PAHs). The remedial goals are 700 ppm total potentially carcinogenic PAH and achievement of the "no leaching potential criteria". The "no leaching potential criteria" are described in Section 3.1 of the SAP.

Soil Washing Pilot Tests

Pilot testing will be performed to determine the methods, equipment, washing agents, and criteria for soil washing. The remedial goals are the same as for the soil flushing test.

Water Treatment Pilot Test

A pilot study of the water treatment system will be performed to define the design of the systems, confirm the effectiveness of the water treatment, and confirm that water quality standards after dilution with Little Whiteoak Bayou, or pretreatment standards for discharge to POTW, can be met. Water to be treated in the water treatment pilot test will be from three sources: the groundwater extraction well pilot test, the trench drain/soil flushing pilot test, and the effluent washwater from the soil washing pilot test. Water to be treated will be mixed and/or diluted to provide the full range of pH levels, and PAH, solvent, and metals concentrations anticipated for water treatment at this site.

For each of the three pilot tests mentioned above, the Work Plan has been structured in a similar general format. First a description or preliminary design of the pilot system has been provided along with specific objectives or design criteria that need to be attained. Data requirements necessary to design the pilot systems along with appropriate justification have been provided. Operational monitoring and/or verification sampling has been specified, and tasks for development of engineering recommendations for full-scale design have been proposed. It is important to note that details regarding sampling protocol, test methods, QA/QC procedures, etc. are detailed in the SAP and QAPP.

Section 2.0 of this document defines the ARARs or regulatory requirements that pertain to the design and operation of the pilot system. Sections 3.0, 4.0, and 5.0 present the trench drain/soil flushing pilot test, soil washing pilot test, and water treament pilot test, respectively. Section 6.0 lists the test methods applicable for the data requirements, Section 7.0 presents an approach to in situ biological treatment, and Section 8.0 presents a tentative project schedule.

2.0 POTENTIAL REQUIREMENTS FOR PILOT PLANTS

2.1 Introduction

As mentioned in Section 1.0, the Record of Decision (ROD) and Statement of Work (SOW) have stipulated that several pilot treatability tests be conducted at the site to confirm attainability of remedial goals and to obtain design information necessary for the full-scale system design. The ROD has identified Applicable or Relevant and Appropriate Requirements (ARARs) for the remedies selected.

SARA defines ARARs as:

- any standard, requirement, criteria, or limitation under any federal environmental law, and
- any promulgated standard, requirement, criteria, or limitation under a state environmental or facility siting law that is more stringent than any federal standard, requirement, criteria, or limitation.

This definition of ARARs requires that many state and federal environmental requirements be considered.

As part of this Work Plan an evaluation of state standards and federal requirements that are applicable to the pilot treatability tests has been performed. Specifically, for each of the pilot treatability tests, state standards and federal requirements that either need to be attained or complied with have been identified. The scope of this Treatability Study Work Plan does not include extraction well pump tests; therefore, ARARs regarding pump test are not present. The following sections identify requirements, including treatment goals, for each of the pilot treatability tests described in this Work Plan.

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2.2 Soil Washing

A pilot test will be performed to determine the applicability of using water and surfactants to desorb the potential constituents of concern (PCOC) from soil. Treated water will be supplied to the soil washing unit from the water treatment unit. Section 4.0 of this report contains a detailed description of soil washing technology.

Treated soils meeting cleanup goals can be stockpiled and subsequently backfilled and capped at the original excavation locations. Soils not meeting the cleanup goals will require further treatment.

Based upon the ROD, the following ARARs have been identified for the soil washing remedy:

- Occupational Health and Safety Act (OSHA)
  (29 CFR 1910)

- Standard for Generators of Hazardous Waste
  (40 CFR 262)

- Closure and Post Closure
  (40 CFR 264 G)

- Waste Piles
  (40 CFR 264 L)

- Control of Air Pollution from Volatile Organic Compounds
  (31 TAC 115)

Table 2-1 contains a listing of action-specific ARARs applicable to the pilot soil washing unit. Soils designated for the soil washing system can be returned to the excavated areas and capped after the total potentially carcinogenic PAH

TABLE 2-1

POTENTIAL ACTION-SPECIFIC ARARs
SOIL WASHING PILOT UNIT
SOUTH CAVALCADE

ACTION	REQUIREMENTS	PREREQUISITES FOR APPLICABILITY	FEDERAL CITATION	TEXAS CITATION
SITE HEALTH AND SAFETY PLAN	Required for the health and safety of on site workers at or near the soil washing unit.	Construction/mobilization of the unit.	29 CFR 1910	
STANDARDS FOR GENERATORS OF HAZARDOUS WASTE	Requires recordkeeping and manifesting by generators of hazardous wastes.	Generation of hazardous waste.	40 CFR 262 B 40 CFR 262 C 40 CFR 262 D	
CLOSURE AND POST CLOSURE	General performance standards require the owner/operator to close a facility in a way which minimizes the need for further maintenance and control; and controls, minimizes or eliminates the post-closure escape of hazardous waste, hazardous constituents, leacheate, contaminated runoff, or hazardous waste decomposition products.	Generation of hazardous waste.	40 CFR 264.111	
	Disposal or decontamination of equipment, structures, and soils.		40 CFR 264.111	
WASTE PILES	Performance standards which require the owner/operators of facilities which store or treat hazardous waste in piles to use a liner and leachate collection system.	Generation of hazardous waste and placement in a waste pile.	40 CFR 264.250	
	Waste put into waste piles are subject to Land Ban restrictions.		40 CFR 268.2	

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TABLE 2-1 (Cont.)

POTENTIAL ACTION-SPECIFIC ARARs
SOIL WASHING PILOT UNIT
SOUTH CAVALCADE

ACTION	REQUIREMENTS	PREREQUISITES FOR APPLICABILITY	FEDERAL CITATION	TEXAS CITATION
EXCAVATION OF SOIL	The movement of excavated soils to a new location may trigger land disposal restrictions for the excavated material.	Material containing RCRA wastes, subject to land disposal restrictions, are placed in another unit.	40 CFR 268.40 (Treatment Stnds)	31 TAC 335.69 31 TAC 335
CONTROL OF AIR POLLUTION FROM VOLATILE ORGANICS	Required for tanks containing volatile compounds.	Use or storage of VOCs.		31 TAC 115

concentration is reduced to below 700 ppm and the leaching criteria, as established by the OLM.

Table 2-2 lists the potentially carcinogenic PAH applicable to the soil washing unit.

2.3 In Situ Soil Flushing

A pilot test will be performed on a selected area using treated water and surfactants to desorb the constituents of concern from the in situ soil into the water phase. After desorbing the PCOC from the soil, the water will be pumped to the water treatment system where the PCOC will be treated and the water will be recirculated to the soil flushing area. Section 3.0 of this report contains a detailed description of the pilot system proposed to accomplish the remedy.

Based upon the ROD, the following applicable laws/regulations have been identified for the in situ soil flushing:

- Occupational Health and Safety Act (OSHA) 29 CFR 1910)
- Standard for Generators of Hazardous Waste (40 CFR 262)
- Closure and Post Closure (40 CFR 264 G)
- Control of Air Pollution from Volatile Organic Compounds (31 TAC 115)

Table 2-3 contains a listing of action-specific ARARs applicable to the pilot in situ soil flushing unit.

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TABLE 2-2

REMEDIAL GOALS
SOIL WASHING/SOIL FLUSHING
SOUTH CAVALCADE

Chemical SOILS (1)	ROD Remedial Goal		
Benzo(a)anthracene	(2)	and	Leaching Criteria (3)
Benzo(a)pyrene	(2)	and	Leaching Criteria
Benzo(b)flouranthene	(2)	and	Leaching Criteria
Benzo(k)flouranthene	(2)	and	Leaching Criteria
Chyrsene	(2)	and	Leaching Criteria
Dibenzo(a,h)anthracene	(2)	and	Leaching Criteria
Indeno(1,2,3-cd)pyrene	(2)	and	Leaching Criteria

(1) Statement of Work (SOW), A-1.
(2) Total Potentially Carcinogenic PAH = <700 mg/Kg, SOW A-2
(3) Achievement of the leaching criteria will be determined by TCLP extraction followed by PAH analysis unless correlation studies determine that the Organic Leaching Model (OLM) adequately predicts the "leaching potential".

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TABLE 2-3

POTENTIAL ACTION-SPECIFIC ARARs
IN SITU SOIL FLUSHING PILOT TEST
SOUTH CAVALCADE

ACTION	REQUIREMENTS	PREREQUISITES FOR APPLICABILITY	FEDERAL CITATION	TEXAS CITATION
SITE HEALTH AND SAFETY PLAN	Required for the health and safety of on site workers at or near the soil washing unit.	Construction/mobilization of the unit.	29 CFR 1910	
STANDARDS FOR GENERATORS OF HAZARDOUS WASTE	Required for the generators of hazardous wastes.	Generation of hazardous waste.	40 CFR 262	
CLOSURE AND POST CLOSURE	General performance standards require elimination of need for further maintenance and control; elimination of post-closure escape of hazardous waste, hazardous constituents, leachate, contaminated runoff, or hazardous waste decomposition products.	Generation of hazardous waste.	40 CFR 264.111	
	Disposal or decontamination of equipment, structures, and soils.		40 CFR 264.111	
PROHIBITION OF AIR CONTAMINANTS ADVERSLY EFFECTING HUMAN HEALTH	Monitoring may be required for certain air contaminants.			.. TAC ...
CONTROL OF AIR POLLUTION FROM VOLATILE ORGANICS	Required for tanks containing volatile compounds.	Use or storage of VOCs.		31 TAC 115

The SOW mandated the same cleanup goals for the in situ soil flushing unit as those stipulated for the ex situ soil washing system. These goals are identified in Section 2.2

2.4 Water Treatment Pilot Plant

The pilot water treatment plant (P-WTP) will use physical/chemical separation followed by activated carbon adsorption to treat water from the soil washing pilot test, soil flushing pilot test, and groundwater extraction well pump tests. The P-WTP will provide design criteria, confirm the effectiveness of the water treatment system, and confirm compliance with discharge standards. Treated water will either be piped back to the in situ soil flushing pilot unit or discharged directly to a storm drain for ultimate discharge to Little Whiteoak Bayou via NPDES permit. Any non-aqueous phase liquids or solids from the pretreatment processes will be handled in accordance with the ROD, Consent Decree, and Statement of Work.

Based upon the ROD, the following ARARs have been identified for the Pilot Water Treatment Plant.

- OSHA
  (29 CFR 1910)

- Water Quality Standards (Criteria)
  (40 CFR 131)

- Criteria and Standards for the National Pollution Discharge Elimination System
  (40 CFR 125)

- Hazardous Materials Transportation
  (40 CFR 106, 171-172)

- Standards Applicable to Generators of Hazardous Waste
  (40 CFR 262)

- Standards Applicable to Transporters of Hazardous Waste (40 CFR 263)

- Standards Applicable to Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (40 CFR 264)

- Land Disposal Restrictions (40 CFR 268)

- Control of Air Pollution from Volatile Organic Compounds (31 TAC 115)

- VOC/Water Separators (31 TAC 101)

The promulgated PCOC limitations of the above laws/regulations concerning pilot-water treatment plants are summarized on Table 2-4.

As per the ROD, the water will be treated to levels equal to Maximum Contaminant Levels and no detectable carcinogenic PAH. Cleansed groundwater will be reinjected into the aquifer along with surfactants to help recover the contaminants. Any excess water will be discharged to a storm drain for ultimate discharge to Little Whiteoak Bayou in accordance with an NPDES permit. Table 2-5 summarizes the potential discharge limitations for the soil flushing pilot test.

TABLE 2-4

POTENTIAL ACTION - SPECIFIC ARARs
PILOT WATER TREATMENT UNIT
SOUTH CAVALCADE

Action	Requirements	Prerequisites for Applicability	Federal Citation	Texas Citation
SITE HEALTH AND SAFETY PLAN	Required for the health and safety of on site workers at or near the soil washing unit.	Construction/mobilization of the unit.	29 CFR 1910	
WATER QUALITY STANDARDS	Required for the protection of drinking waters.		40 CFR 131	
NPDES DISCHARGE	Establishes permit limitations for the discharge of pollutants into navigable waters.	Must discharge into a navigable water.	40 CFR 125	
HAZARDOUS WASTE TRANSPORTATION	Manifesting, worker training required.	Generation of hazardous waste.	40 CFR 106, 171-172	
STANDARDS FOR GENERATORS OF HAZARDOUS WASTE	Required for the generators of hazardous wastes.	Generation of hazardous waste.	40 CFR 262 B-D	
STANDARDS APPLICABLE TO TRANSPORTERS OF HAZARDOUS WASTE	Required for the transporters of hazardous waste.	Generation of hazardous waste.	40 CFR 263	
STANDARDS FOR OWNERS AND OPERATORS OF HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL FACILITIES	Establishes requirements for protecting the public and environment from potential releases from solid waste units.	Use of solid waste units.	40 CFR 264 F	
	Establishes requirements for protecting the public and environment from potential releases from tank systems.	Use of tank systems.	40 CFR 264J	
LAND DISPOSAL RESTRICTIONS	Required for landfill disposition of hazardous waste.	Generation of hazardous waste.	40 CFR 268	

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TABLE 2-4 (Continued)
POTENTIAL ACTION - SPECIFIC ARARs
PILOT WATER TREATMENT UNIT
SOUTH CAVALCADE

Action	Requirements	Prerequisites for Applicability	Federal Citation	Texas Citation
CONTROL OF AIR POLLUTION FROM VOLATILE ORGANICS	Required for tanks containing volatile compounds.	Use or storage of VOCs.		31 TAC 115
VOC/WATER SEPARATORS	Air monitoring may be required.	Use of VOC/water separation device.		31 TAC 101

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TABLE 2-5

POTENTIAL DISCHARGE LIMITATIONS
SOILS FLUSHING
SOUTH CAVALCADE

Chemical	RCRA MCLs mg/L	ROD ug/L
Benzo(a)anthracene	—	ND
Benzo(a)pyrene	—	ND
Benzo(b)flouranthene	—	ND
Benzo(k)flouranthene	—	ND
Chyrsene	—	ND
Dibenzo(a,h)anthracene	—	ND
Indeno(1,2,3-cd)pyrene	—	ND
Arsenic	0.05	—
Chromium	0.1(1)	—
Lead	0.05	—

(1) Effective June 1992.

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3.0 IN SITU SOIL FLUSHING PILOT SYSTEM

3.1 Implementation Approach for the Pilot System

Implementation of the pilot system will be achieved through a sequence of related investigation, design, and operation activities. These activities are necessary to implement the pilot test, and consist of the following tasks:

- Obtain predesign data,
- Estimate system performance,
- Develop design drawings for submittal to Agencies for approval,
- Refine design,
- Develop construction specifications,
- Complete operation and testing plan for the soil flushing plot,
- Construct pilot test plot,
- Operate pilot test plot, and
- After initial 8 month operating period, begin preparation of the "Report of Findings".

Each of these tasks is briefly discussed below:

Predesign Data

The design data will be presented in tabular form, discussed, and evaluated to support the below grade system design as identified in Section 3.1.5. Any existing data which are applicable to the design will also be currently presented to fully depict the site.

Design Drawings

The design drawings will provide sufficient detail to develop cost estimates, solicit bids, and construct the pilot facilities. A plan view, profiles, and design details prepared in standard engineering format will be presented.

Construction Specifications

The construction specifications will generally be performance specifications that define the requirements for the completed construction. The specifications will provide requirements for construction of the pilot system.

Operation and Testing Plan

The operation and testing plan will describe and identify the methods to monitor the soil flushing test plot. This plan will be submitted to EPA as part of the Pilot Study Design document. Piezometers and/or monitoring wells will be proposed for installation in the different units that have been identified (fill, sandy clay, and silty sand) within and outside the test area to verify the functioning of the recovery trench. Various types of piezometers will be evaluated and an appropriate monitoring device will be specified in response to soil conditions encountered during the site investigations.

In addition, changes in the operation of the system will be scheduled, such as increased infiltration or extraction rates. The operational plan will be used as a guidance document during the duration of the pilot test. The plan must be flexible to allow for field adjustments in response to system performance or possible environmental factors, such as precipitation events.

Report of Findings

At the completion of the scheduled pilot test (i.e. eight months), the report of findings document will be developed describing the results of soil flushing operations. In addition, a recommendation will be made for further operation of the test, termination of the test, or viability of the system. If appropriate, recommendations for implementing changes in the operation and/or flushing solutions will be provided. Once the pilot test is complete, the results will be used to determine if in situ soil flushing will be effective for soil remediation at the South Cavalcade site and also to provide design data for full-scale implementation, if soil

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flushing is determined to be effective. An outline for the report is presented in Table 3-1.

3.1.1 Objectives

The objective of the in situ soil flushing remediation is to reduce the concentration of potential constituents of concern (PCOC) in the vadose zone soils to the levels identified in Table 2-2 and the ROD (September 1988). These levels will be achieved by causing the flushing solution to flow through soil pores, dissolving and displacing the PCOC from the soil matrix. The pilot soil flushing system will be operated to obtain data for a full-scale system. The objectives of the below grade pilot system are:

- To evaluate the flushing rate achieved to estimate treatment time, fluid volumes, and overall viability of soil flushing;

- To evaluate the distribution of the flushing solution to the subsurface, to determine an effective distribution system;

- To evaluate the shallow collection trenches to determine size, spacing and recovery rates; and

- To evaluate the effectiveness of the deep collection trench in comparison to a recovery well system.

The ROD issued for the South Cavalcade site stipulated that a pilot in situ soil flushing system be tested to confirm the effectiveness of the remedial technology and to obtain design information for a full-scale system. This section provides a description of the technology, objectives, data requirements, design, construction, operation, and verification sampling for the pilot in situ soil flushing system. It should be noted that sufficient data is not present at this time to provide a detailed design of the pilot system. This section presents the data required to achieve a detailed design and a preliminary design on which the final design will be based. For presentation purposes, the Work Plan for the in situ soil flushing pilot system

TABLE 3-1

OUTLINE FOR REPORT OF FINDINGS

1.0 Introduction

- 1.1 Objectives
- 1.2 Background
  - 1.2.1 History
  - 1.2.2 Extent of Potential Impact
  - 1.2.3 Technology Description
- 1.3 Report Organization

2.0 Summary of Sampling and Field Testing

3.0 Study Procedure

4.0 Study Results

5.0 Conclusions and Recommendations

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has been segregated into below grade and above grade systems. Accordingly all components associated with the treatment area (i.e. trenches, distribution pipes, etc.) are included in the below grade system description, whereas the surfactant addition and pH control components are described as part of the above grade system.

3.1.2 Required Data for Design

To design and operate an in situ soil flushing system, data is required defining site conditions and physical soil characteristics. The required data is identified in Table 3-2 and discussed below.

The in situ conditions and characteristics of soils in the treatment area must be determined (EPA 1990). The location and characteristics of the soils to be treated must be clearly defined to include the areal extent, depth distribution, and level of PCOC impact. The subsurface profile, classification, characteristics and consistency of the soils are required for an understanding of site conditions and to design the system. The type of soils to be treated, and their physical properties, must be determined and should include grain size distribution, Atterberg limits, moisture content, consistency and in situ conditions.

To predict/evaluate the performance of the system, the effect of the flushing solutions on the soil properties and the PCOC must be determined. Changes to the permeability of the underlying soils could have a significant effect on the performance of the system. Clay soils, such as those at the site, can be affected by changes in pore fluids and pH adjustments, which can be caused by the addition of surfactants to the flushing solution; therefore, compatibility testing of the in situ clays and the bentonite-soil barrier is proposed to determine if adverse impacts may occur. The effect of the surfactants on the in situ soils and PCOC have been evaluated by laboratory bench scale tests, which are discussed in Section 3.2.4.

TABLE 3-2

REQUIRED DATA FOR IN SITU SOIL REMEDIATION

- Location, extent and degree of PCOC before, during, and after operation of the pilot system
- Vertical and horizontal distribution of the various soil types
- In situ soil conditions and subsurface profile
- Classification and physical tests: standard penetration test values, grain size with hydrometer, natural moisture content, specific gravity, Atterberg limits, unit weight
- Location of the water table and groundwater flow directions
- Percolation (Infiltration) rates for the surface soil (0 to 3 feet depth)
- Vertical permeability of subsurface soils (3-9 feet deep) and underlying aquifer (9-23 feet deep)
- Compatibility testing on soils with respect to flushing solutions
- Compatibility testing on bentonite-soil barrier with flushing solutions

3.1.3 Summary of Background Data

Some site specific data of the near surface soils (less than six feet deep) designated for soil flushing and of the clay aquitard (starting at 23 feet deep) within Area 1 are summarized in the RI report. The most useful data for design considerations were the visual classifications of samples from the soil borings. Physical tests performed on the near surface soils were very limited and not sufficient for design requirements. Existing data is insufficient for design of the soil flushing system.

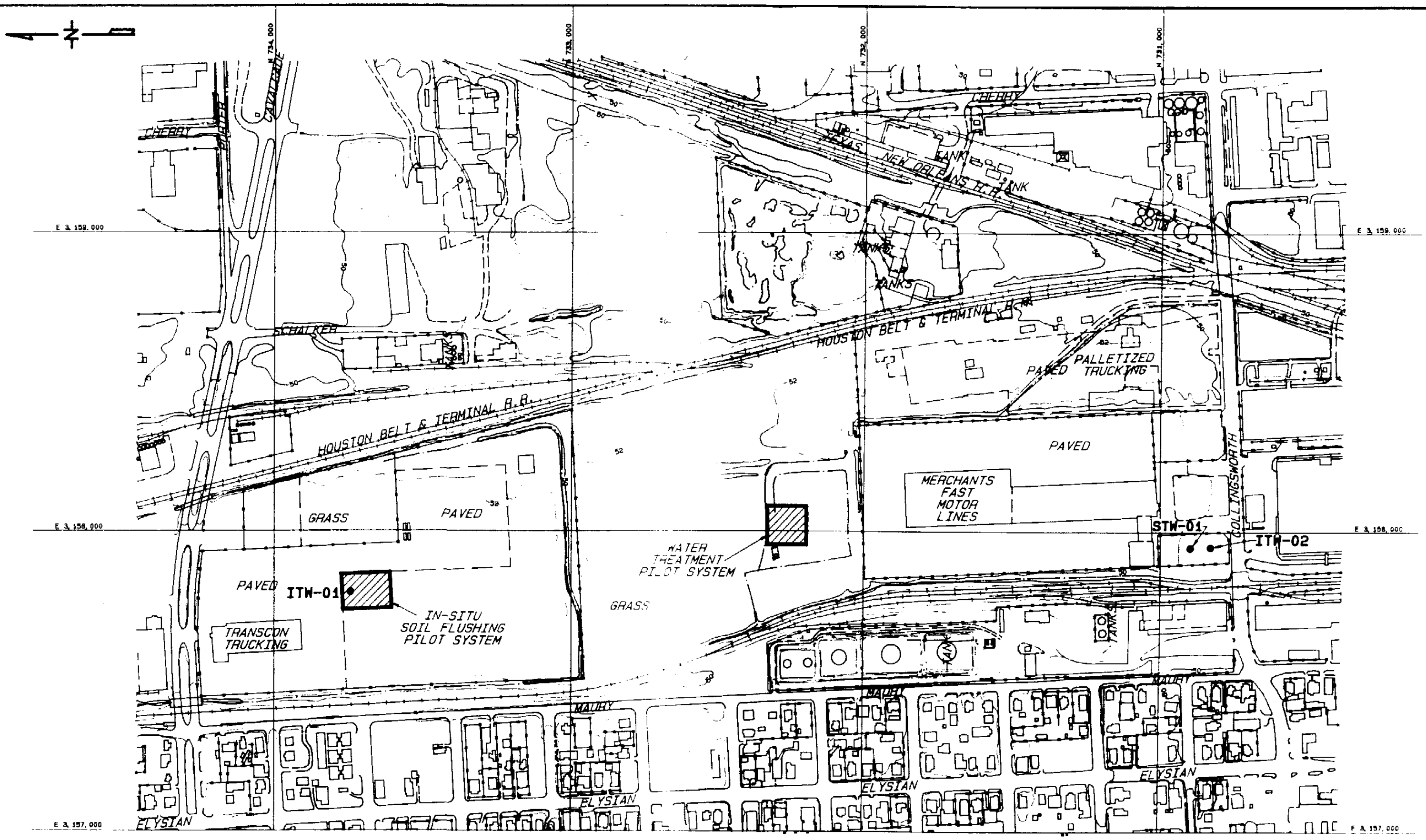
The location proposed for the soil flushing pilot test is a relatively flat area at an elevation of about 51 feet above mean sea level in the northwest quadrant of the site as shown on Figure 3-1. The treatment area is part of Area 1 (Keystone 1988, Bechtel 1990). It is approximately 120 feet by 80 feet in plan and is bounded on two sides by parking lot pavement. Seven soil borings and eleven auger borings were completed in this area. Data generated during this program was not applicable for design of the pilot soil flushing system.

A general description of the near surface soils in Area 1 is presented as follows:

Depth, Ft	Description
0-3	Fill: Silty Fine Sand
3-9	Soft to very stiff Sandy Clay
9-23	Medium to very compact Fine Sand
23-80	Very stiff to hard Clay and Silty Clay

The first three types of underlying soils (fill, sandy clay, and sand) constitute the "shallow zone" which is underlain by an aquitard (part of the "upper intermediate zone") consisting of predominantly clayey soils. The upper sand layer is identified as an unconfined shallow aquifer (Keystone, 1988). Pumping tests were completed for this zone resulting in a calculated mean permeability of 8.3 x 10^{-4} cm/sec. Hydraulic conductivity tests of the fill and sandy clay in the shallow zone have not been performed.

[redacted]



SCALE (FEET)
0 150 300

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FIGURE 3-1
APPROXIMATE LOCATION OF WATER TREATMENT PILOT SYSTEM, IN SITU SOIL FLUSHING PILOT SYSTEM AND TEST WELLS
S. CAVALCADE SITE, HOUSTON, TX
(AREA OF SYSTEMS NOT TO SCALE)

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The piezometric water level in the silty sand unit near the pilot test area varied from an approximate depth of 6 to 7 feet (Keystone, 1988), which is a few feet above the physical surface of the sand unit. At this location, the sand unit appears to be a confined aquifer; confined above by the sandy clay of the shallow zone and below by the clayey soils in the upper intermediate zone. The groundwater flow direction is generally toward the west, with a hydraulic gradient of 0.004 ft/ft.

Twelve undisturbed samples of the lower clay were obtained from depths of 25 to 67 feet (Keystone 1988). None of these samples were from borings within Area 1. It is likely that these clays are the same as those in Area 1; however, no data are available to substantiate this. One of the samples was sandy with a low plasticity index and is considered an anomalous sample; therefore the results will not be considered. The mean permeability for the other clay samples was calculated to be 3.4×10^{-9} cm/sec. The clays were classified by the Unified Soil Classification System as CL or CH with a mean plasticity index of 43.

In the RI, grain size curves were presented for two samples of the sand layer at a depth of twelve feet from locations within 500 feet of Area 1. The material was classified as a fine sand with about 16% passing the number 200 sieve. The only other physical soil test data, presented in the RI, are for ten deeper soil samples. These samples were obtained from depths of 33 to 194 feet, and are not useful for the below grade system design.

3.1.4 Data Required but Not Currently Available

Of all the data requirements identified in Table 3-2, the only requirements which are satisfied at this time are the groundwater flow direction and a general subsurface profile. The additional data required for design of the below grade pilot system include the following:

- <u>Limit and extent of soils containing PCOC</u> -- The horizontal and vertical extent and concentrations of PCOC in the area soils must be better defined to establish the areal extent required for soil flushing remediation. The nature and extent of the PCOC have been addressed in the SAP.

- Classification and physical properties of in situ soils -- Soil samples must be obtained for visual classification and laboratory testing. Site conditions should be characterized by Standard Penetration Tests and visual observations. Field and laboratory tests on the soils should include:

Standard Penetration Test	ASTM D 1586
Visual Classification	ASTM D 2487
Particle Specific Gravity	ASTM D 854
Grain Size Distribution	ASTM D 422
Atterberg Limits	ASTM D 4318
Natural Moisture Control	ASTM D 2216
Unit Weight In-Place and Dry	

- Permeability of in situ soils - Permeability values are required for the near surface soils in the soil flushing test area (Area 1). Field permeability tests should be performed for the soil fill (0 to 3 feet interval) and the upper aquifer (10 to 20 feet interval). Undisturbed ("Shelby Tube") samples of the clayey soils must be obtained for the determination of soil permeability in a laboratory. Laboratory tests will be completed for the sandy clay and the deeper clay soils (depth of 20 feet and greater).

  The following permeability tests should be performed:

Soil Fill:	Percolation tests at two depths (6 inches to 12 inces and 18 inches to 24 inches).
Sandy Clay:	Laboratory permeability tests on undisturbed samples using the flexible membrane method.
Upper Aquifer:	Recovery slug test (field permeability) within a 4-inch I.D. slotted screen.

Clay Aquitard: Laboratory permeability tests on undisturbed samples using the flexible membrane method.

- Flushing solution soil compatibility data - Undisturbed ("Shelby Tube") samples of the clayey soils must be obtained for the flushing solution compatibility testing. Laboratory testing will be completed for the sandy clay and the deeper clay soils (depth of 20 feet and greater).

The following tests should be performed:

Sandy Clay	Laboratory dispersivity (ASTM D 4221) and permeability test (SW 925) on undisturbed samples using the flexible membrane method.
Clay Aquitard	Laboratory dispersivity (ASTM D 4221) and permeability tests (SW 925) on undisturbed samples using the flexible membrane method.

3.1.5 Activities to Obtain Necessary Data

A soil boring, sampling, and field testing plan is proposed to obtain samples and data needed to plan and design the soil flushing pilot test (see Section 3.2 of the SAP). Samples will be obtained and laboratory tested for classification, physical, and permeability data. Field testing will be performed to obtain data on the in situ conditions and field permeability of the soils.

Soil Boring and Sampling

A soil boring, sampling and field testing program is proposed as shown on Figure 3-2. The soil borings will be advanced with continuous split-spoon sampling to a depth of about 25 feet. Undisturbed ("Shelby Tube") samples will be obtained from

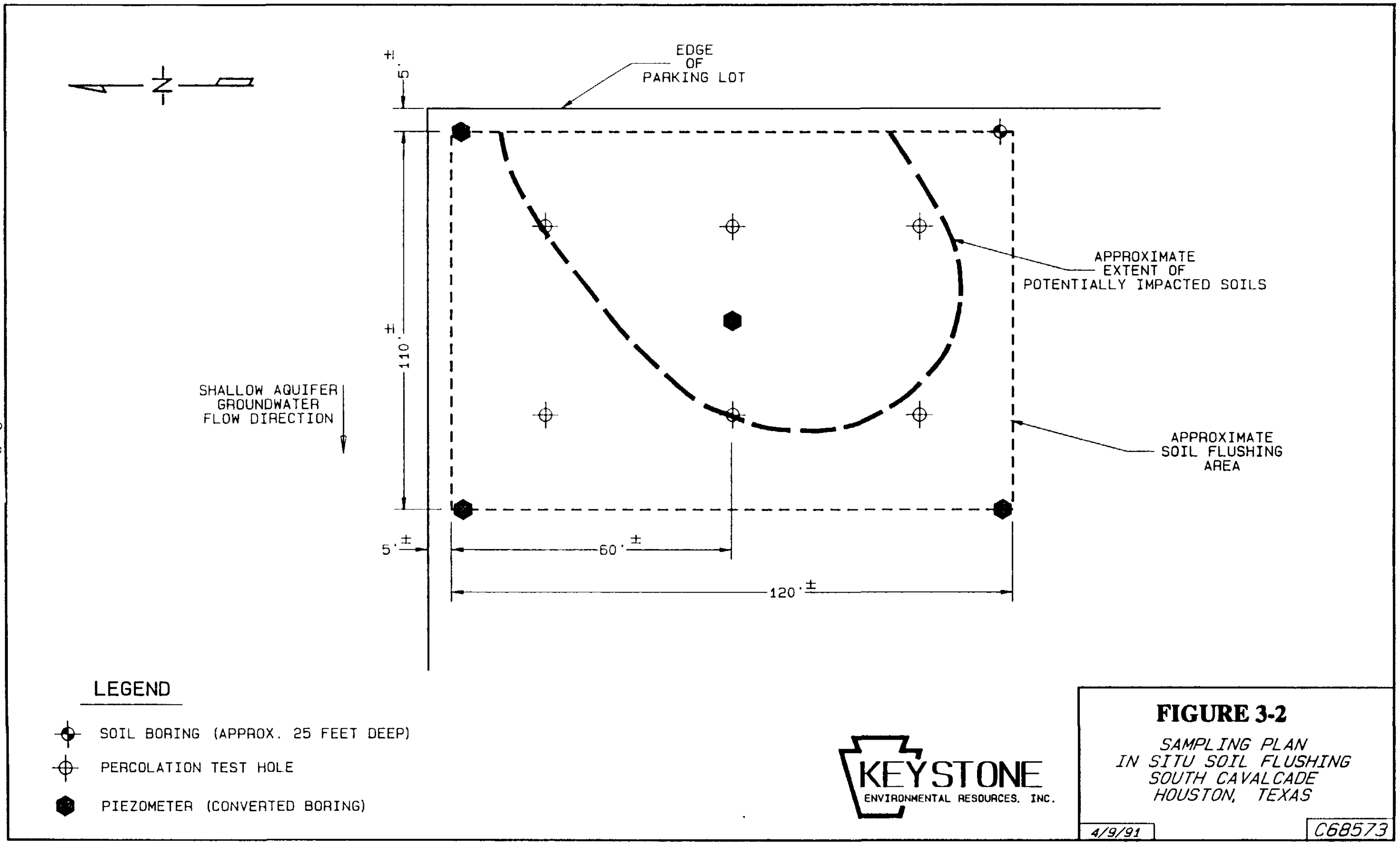

FIGURE 3-2

SAMPLING PLAN
IN SITU SOIL FLUSHING
SOUTH CAVALCADE
HOUSTON, TEXAS

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the sandy clay and underlying clay aquitard for laboratory tests. The Standard Penetration Test values and visual classification of samples will be recorded to characterize the subsurface conditions of the pilot test area.

The drilling and logging procedures will be completed following SOP 304 (Appendix A, SAP). Soil samples will be obtained and preserved for laboratory tests for classification and physical properties of each soil type encountered. The soil types will be identified by visual classification of the split-spoon samples.

Field Testing Program

Field permeability tests will be performed to obtain infiltration and permeability values of the soil fill and the upper aquifer (sandy unit). For the upper aquifer, in situ slug tests through fully penetrating, 4-inch diameter slotted PVC piezometers are proposed. In addition, falling and recovery head tests should be performed at several of the test boring locations.

For the soil fill (0 to 3 ± feet depth) percolation tests will obtain permeability data at two depths at each location. The percolation tests will be conducted following the double ring infiltrometers test procedure (ASTM D 3385). The percolation holes should be tested at the 6- to 12-inch and 18- to 24-inch intervals. The infiltration of water into each interval should be evaluated until a constant infiltration rate is achieved, or a maximum of four tests per interval are completed.

Laboratory Testing Activities

Laboratory tests will be performed on representative samples of each soil type encountered in the soil boring phase. The samples will be selected based on visual observation and previous experience. The number and types of tests for each soil type are as follows:

Soil Property	Test Method	Soil Type			
		Soil Fill	Sandy Clay	Silty Sand	Clay Aquitard
Grain Size	ASTM D 422	3	3	3	3
Moisture Content	ASTM D 2216	3	3	3	3
Atterberg Limits	ASTM D 4318	--	3	--	3
Specific Gravity	ASTM D 854	1	1	1	1
Unit Weight		--	3	--	3
Permeability	SW 925	--	3	--	3

The compatibility testing is further discussed in Section 3.1.6.

3.1.6 Compatibility Testing

The compatibility testing will determine the affect of the flushing solution on the permeability of the clay materials. The flushing solution will be passed through an undisturbed sample of the clay material in a laboratory triaxial cell. Several pore fluid volume exchanges are generally required to alter the properties of a clay soil, and since the clays have low permeability, considerable time is required to complete testing. The test results may not be available for design of the pilot test system, but these results are necessary for assessing the viability of the full-scale system. The two clay layers identified in the soil profile plus a laboratory fabricated soil-bentonite mix will be tested. Currently, two surfactants and chemicals to adjust the pH will be introduced into the flushing solutions. Candidate additives to the flushing solutions and the mixture to be used in the actual pilot test will be used for the compatibility tests.

Two permeability tests for each flushing solution will be completed using samples of the upper clay, aquitard, and the bentonite/soil mix. For comparison purposes, one control permeability test for each material will be completed.

No standard testing method exists for this procedure though similar testing is performed on slurry walls and liner material. A more detailed procedure will be developed prior to sample collection.

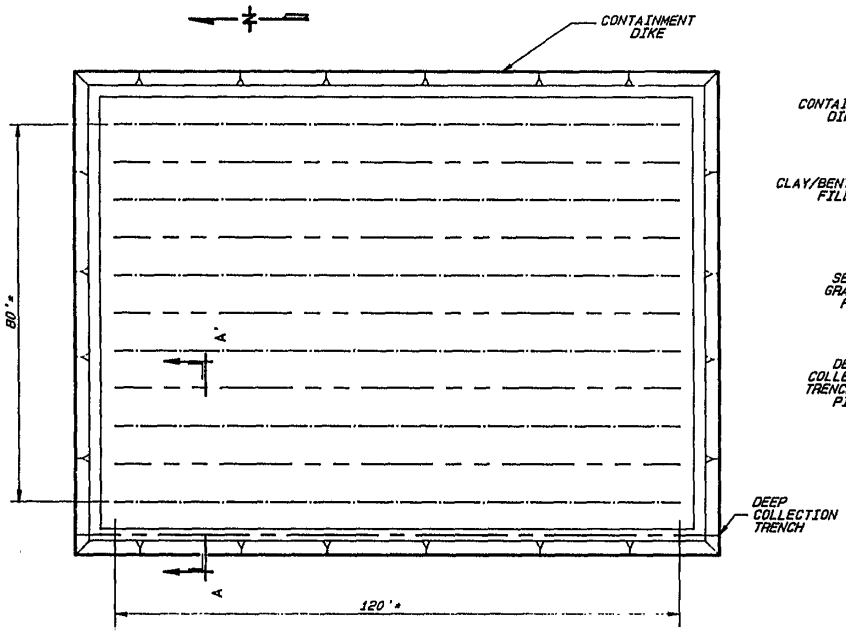
Soil Dispersion or Physical (Index) Properties

Some index-type testing may be completed in the laboratory on bulk soil samples to identify changes in physical properties caused by a change in pore waters (such as the flushing solutions). As a quick indicator test, the dispersive nature of the clay soils can be determined by the ASTM D 4221 test method. The advantage of these tests are that an indication of whether the clay soil is dispersed by the flushing solution can readily be obtained. At least three samples of each clay soil (i.e., the sandy clay and lower clay) that may be affected by the flushing solutions should be tested according to ASTM D 4221.

3.1.7 Pre-Conceptual Design

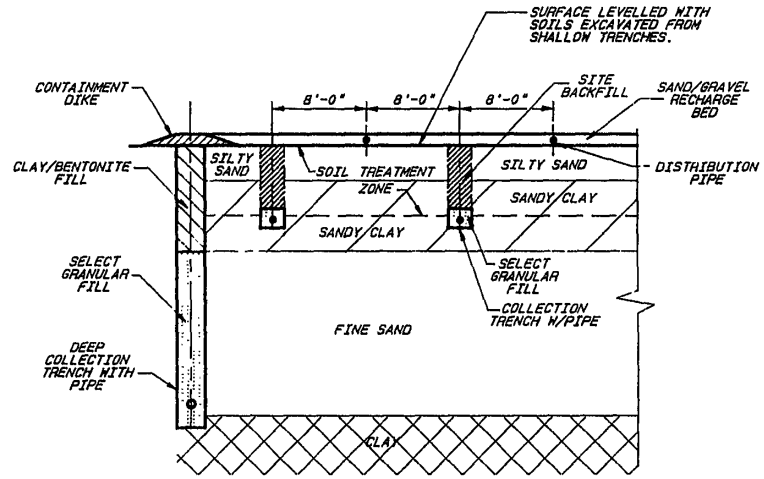
The soil flushing pilot test is designated for Area 1, a rectangular area approximately 120 by 80 feet in plan. The near surface soils are reported to contain PCOC at concentrations requiring remediation to a depth of about 6 feet within this area. Based upon the available site data, mostly stratigraphy, a preliminary conceptual design is provided to guide planning and development of the pilot-scale test. Also, a preliminary estimate of the flushing and collection flow quantities will be presented to guide planning of the above grade treatment system. A schematic of the pre-conceptual design is presented in Figure 3-3. It should be noted that this design may vary depending upon results of additional investigation.

A protective, secondary collection trench is proposed along the entire west, downgradient side of the test plot. This collection trench will be excavated using slurry construction techniques about 24 feet deep through the shallow zone, requiring excavation of approximately 230 cubic yards (CY) of soil. The quality of the trench soils will be determined by field testing (using a mobile GC of each split spoon sample from the three borings) located along the proposed trench alignment. If the deep trench soils meet the remedial goals, 144 CY of excess soil not replaced



PLAN: IN-SITU SOIL FLUSHING PILOT AREA

SCALE FEET
0 10 20 30



CROSS-SECTION A-A'

SCALE FEET
0 4 8 12

LEGEND:

——·——·—— = COLLECTION TRENCH PIPE

— — — — — = DISTRIBUTION PIPE

NOTE:

ACTUAL DESIGN MAY VARY DEPENDING UPON ACTUAL SITE CONDITIONS.

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FIGURE 3-3
PLAN AND CROSS-SECTION
OF IN SITU SOIL FLUSHING
PILOT AREA
SOUTH CAVALCADE
HOUSTON, TEXAS

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in the trench will be used for dike construction or, if the soil does not meet remedial goals, spread over the bed for treatment. The bottom of the deep collection trench will be keyed about one foot into the clayey soils of the upper intermediate zone. The underlying clay soil aquitard is located at a depth of about 23 feet in Area 1. This collection trench will intercept any leakage through the sandy clay layer. The collection trench may have a geomembrane installed on the downgradient sidewall, reducing inflow of downgradient groundwaters into the trench. The collection trench system will be evaluated and designed to capture the PCOC's and flushing solution.

Shallow collection trenches will recover the flushing solutions using a stone-filled pipe drain installed at a depth of about seven feet in the upper sand layer. These collection trenches, approximately six segments, each about 120 feet long, will recover the flushing solution at the base of the potentially impacted soil zone. Approximately 375 CY of soil will be excavated for trench construction. About 80 CY of granular fill will be placed in the bottom of the trenches and the excavated soils will be used to backfill the trench excavations. Any excess soils will be spread evenly over the treatment bed area for treatment during operation of the system. The shallow trenches will expedite recovery of flushing solution and enhance the soil remediation.

The pilot test area should be graded to a flat horizontal surface after installation of the shallow collection trenches and prior to the installation of the recharge bed system. A base course consisting of four inches of gravel should be laid over the leveled surface and base of the recharge area.

The recharge area will include a grid of perforated pipes to distribute the flushing solution throughout the recharge area over the soils in the flow-through zone. Four-(4) inch diameter distribution pipes will be located at a horizontal spacing of about sixteen feet center to center and will be covered with about eight inches of gravel. This gravel layer will serve to protect the recharge system and more evenly distribute flushing solution. An evaporation barrier and soil cover will minimize evaporation losses and the recharge area will be surrounded by a small earthen dike

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to prevent flushing solution from seeping laterally out of the test area. The dike will be designed to impede the horizontal flow of flushing solution from the test area.

Flow quantities for the recharge area and collection trenches were estimated to facilitate the initial planning of the below and above grade systems; however, the estimate provided here is a starting point for designing the system and may change as additional site data are collected. Note that the current system is expected to saturate most of the treatment bed, which will create an artificial perched water table above the current groundwater level. The shallow groundwater zone will be collected by the deep trench and may be collected in the shallow trenches. If the shallow groundwater level is artificially lowered by pumping, the perched water table is expected to persist, the treatment bed soils would remain saturated, and any PCOCs flushed from the soil will continue to be collected in the trench system.

The rate of recharge of flushing solution is likely to be limited by the hydraulic conductivity of the shallow sandy clay unit (3-9 ft) which should be less permeable than the silty fine sand (0-3 ft). Assuming a permeability of 1.0×10^{-5} cm/sec for this sandy clay unit and a downward unit hydraulic gradient, the sustainable influent rate would be approximately 2,900 gallons per day (gpd). Using Darcy's Law, the average flow rate is estimated at 2 gallons per minute (gpm). The shallow trenches should recover the influent flushing solution at a rate of about 2 gpm. After site specific permeability data becomes available, consideration will be given to tilling or augering the soil to improve the permeability.

The rate of pumping from the deeper collection trench will be determined by the local hydrogeology and the design of the collection trench. Assuming a permeability of 1.0×10^{-3} cm/sec for the silty sand zone, and the placement of a downgradient barrier, a minimum pumping rate of approximately 2,900 gpd from the deeper collection trench will be required to hydraulically isolate the pilot test area. This corresponds to an average flow rate estimated at 2 gpm. Accordingly, the total amount of flushing solution and shallow groundwater recovered will be 5,800 gpd, an average rate of 4 gpm. The actual influent and effluent rates to be used for design of the pilot-scale system will be determined after completion of the site specific testing described in Section 3.1.5.

The time required for one flushing is estimated to be between 2.5 to 4 months with an assumed porosity of 0.30. In addition, about 100,000 gallons of water will be required to saturate the recharge area and soils in the treatment zone. Once site specific data is available, a more accurate flow estimate can be completed.

3.1.8 Design of Additional Soil Flushing Systems

Depending on the results of the pilot test, additional full-scale systems might be designed. A similar site investigation and laboratory testing process may be required for additional systems, but the new program would benefit from the data collected during the pilot program. Additional borings may be required in the additional treatment areas, along with geotechnical and hydrogeological data. The design and implementation approach would be developed and identified in a supplemental work plan. Information obtained during the construction and monitoring of the pilot system would be used to calibrate and update the model, allow for improved system design in the additional systems, and allow evaluation of any interactive affects with the groundwater recovery system.

Operation of the groundwater system is expected to positively impact the soil flushing system in the following manner. The groundwater recovery system will provide a backup system for the shallow trenches to collect the flushing solution. The design of the flushing system may take advantage of the aquifer containment system and eliminate the redundant shallow trench system. Additionally, the flushing delivery system may provide recharge to the shallow aquifer and improve the effectiveness of the groundwater recovery system. The interaction of the systems will be considered during design of the full-scale systems.

3.2 Above Grade System

The above grade components of the in situ soil flushing pilot unit pertain to the surfactant addition and pH control equipment. It is assumed the water collected from the below grade system described in Section 3.1 will be treated along with other site waters in a physical/chemical and activated carbon treatment system.

Only enough treated water needed to flush the below grade area will be enhanced in the above grade flushing system. The remaining waters will be discharged to the pilot soil washing unit or to surface water via an NPDES permit.

3.2.1 Objectives

The objectives of evaluating the above grade components of the in situ soil flushing system during the pilot studies are: (i) to develop data necessary for design of the full-scale pH adjustment system, the surfactant addition system, and other equipment that comprise the above grade components, and (ii) to confirm the effectiveness of the selected surfactant combination and surfactant dosage to flush the potential constituents of concern (PCOCs) from the soil into the liquid phase in a full-scale system.

3.2.2 Location of System

To facilitate the day to day operation of the above grade equipment associated with the in situ soil flushing pilot-scale system, most of the equipment will be located in the center area of the site near the on site water treatment pilot facility (see Figure 3-1). This will include the pH control unit and the inline surfactant addition system. The pH adjusted injection water, mixed with surfactants, will be conveyed to the below grade in situ soil flushing pilot system located in the northern portion of the site.

3.2.3 Injection Water Source

The major source of recharge water for the pilot in situ soil flushing system is the effluent from the pilot water treatment plant. If treated effluent is not available during start-up of the pilot system, or is available in insufficient quantities, tap water will be used to make up the injection water.

3.2.4 Selection of Surfactant

Previous Laboratory Studies

Soil column studies using percolation of site groundwater containing surfactants to simulate in situ soil flushing were not conducted in the previous treatability studies ("Appendix A - Treatability Laboratory Report, Feasibility Study, South Cavalcade Site, Houston, Texas, August 1988"). During the laboratory soil washing treatability studies conducted as part of the Feasibility Study, several surfactants were evaluated to determine their potential for removal of PCOC in surface and subsurface soils. Of the surfactant combinations evaluated, Rhome and Haas Triton X-100 and Witco Emcol Cocobetaine appeared to be effective, achieving about 78 - 99% removal of total PAH and about 98 - 99% removal of oil and grease concentrations in two wash cycles. The pH was maintained at 10 by addition of 2.5 - 4.0 mls of 20 wt.% sodium hydroxide. These batch soil washing tests employed two, 45-minute wash cycles, followed by one, ten-minute rinse cycle. The aqueous surfactant solution used for the first wash contained 0.338 grams of Triton X-100 and 0.320 grams of Emcol Cocobetaine in 2,500 ml of water. This was used to wash 500 grams of soil. This aqueous solution contained 0.026 wt.% total surfactant, resulting in a surfactant to soil weight percent of 0.132%.

Selection of Surfactant and Dosage

Since the surfactant combination of Rhome and Haas Triton X-100 and Witco Emcol Cocobetaine appeared to be effective in removing PCOC from the soil during laboratory soil washing studies, these two surfactants will be utilized during the pilot in situ soil flushing studies. Triton X-100 is a nonionic surfactant and Emocol Cocobetaine is an amphoteric surfactant.

Preliminary surfactant dosages for the pilot study are also based on the previous laboratory soil washing test results. Based on the total mass of soil contained in the approximately 120 feet long x 80 feet wide x 6 feet deep plot proposed for the in situ soil flushing pilot study, and a surfactant to soil weight percent of 0.132% to be achieved in a six-month period, the rate of surfactant injection to be achieved in the

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recharge flow of 2 gpm (maximum) was calculated to be approximately 14.7 grams/minute. This will contain about a 1:1 weight ratio of Triton X-100 and Emcol Cocobetaine and will result in a total aqueous surfactant concentration of 0.194 wt.% (1935 mg/l). However, the total initial surfactant injection rate used in the recharge line will be approximately 1.98 grams/minute which will correspond to an aqueous surfactant solution concentration of 0.026 wt.%, (i.e., 260 mg/l). This was the concentration of the aqueous surfactant solution used during the soil washing laboratory treatability studies. The surfactant dosages will be refined during the in situ soil flushing pilot studies.

It is expected that a total aqueous surfactant solution concentration of 0.026 wt.% (260 mg/l) will be used initially and gradually increased to 0.194 wt.% (1,935 mg/l), depending on the results obtained during in situ soil flushing. The pH of the recharge water will be adjusted to 9-10. The optimum pH will be confirmed during the pilot study. After approximately six months of flushing with surfactants, the soil will be rinsed with treated effluent or tap water. The results obtained from soil verification sampling and analysis (Section 3.2.5) and recovery water sampling and analysis (Section 5.4) will help assess the performance of the in situ soil flushing program. The surfactant injection rates and flush/rinse cycles will be adjusted accordingly.

As discussed in the above paragraphs, soil column laboratory studies simulating in situ soil flushing were not conducted during the previous treatability studies. Preliminary surfactant dosages (aqueous surfactant solution concentrations of 0.026 wt. % to 0.194 wt. %) and pH conditions (pH 9-10) to be used were selected from the best available site-specific information, based on the soil washing treatability studies. The intent of the pilot-scale in situ soil flushing studies is to evaluate optimum surfactant dosages and pH conditions for a field scale unit and from a scale up point of view. This is because there may not necessarily be a linear relationship between laboratory soil washing studies and field scale in situ studies due to differences in transport, surfactant/soil mixing, etc.

The results obtained from the intermediate (after 3 months) soil verification sampling and analysis (Section 3.2.5) and periodic recovery water sampling and analysis will be evaluated to assess the progress of the in situ pilot system. The surfactant dosages, pH and flush/rinse cycles will be adjusted, if necessary, to optimize these parameters. The data obtained during the pilot-scale studies, which will represent site-specific conditions, will be used in scaling up to the full-scale system.

Prior to implementing the pilot study, available information regarding the environmental fate of Triton X-100 and Emcol Cocobetaine in groundwater will be collected from Rhom and Haas/Witco and by conducting a literature search. The information collected will be used to modify the study, as required.

3.2.5 Soil Verification Sampling and Analysis

To assess the performance of the in situ soil flushing system, verification soil samples will be collected at three different times and analyzed according to the schedule presented in Table 3-3. Samples collected and analyzed before the start of the pilot tests will serve as baseline measurements. An intermediate soil sampling event after approximately three months of operation will serve to assess the progress of the soil flushing activity. Soil samples will also be collected at the end of the soil flushing pilot studies, (i.e. at about eight months) to verify the feasibility of this technology for soil remediation at the South Cavalcade site.

The interval between sampling events as presented in Table 3-3 was based on the preliminary estimate of the time required for one change in pore volume (one flushing), which is expected to be between 2.5 to 4 months. The sampling event at 3 months will establish the progress of the pilot in situ system after approximately one flushing. The 8-month sampling event results will be used to evaluate the degree of treatment achieved relative to the clean up goals after a second flush cycle and one clean water rinse cycle (i.e., a total of approximately 6 months for two flush cycles and 2 months for one rinse cycle).

The remedial goals for soils are that the total potentially carcinogenic PAH be less than 700 ppm and that soils will have "no leaching potential" for total potentially carcinogenic PAH. The "no leaching potential criteria" will be determined during

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TABLE 3-3

SOIL VERIFICATION SAMPLING SCHEDULE

Parameter	Day 0 (1)	Month 3	Month 8
Oil and Grease	X	X	X
pH	X	X	X
Polynuclear Aromatic Hydrocarbons (PAH)	X	X	X
TCLP (leachate)(2):			
Potentially Carcinogenic Polynuclear			
Aromatic Hydrocarbons (PAH)			X
Microbial Count	X		X

(1) Indicates data will be collected prior to initiation of treatment.

(2) If correlation studies determine that the OLM adequately predicts the "no leaching potential criteria," TCLP extraction and leachate analysis will be limited to 25 percent of final set of soil samples collected.

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the soil grid delineation by cPAH analysis of soil followed by TCLP and cPAH analysis of the resultant leachate, as described in the SAP. If correlation studies determine that the OLM adequately predicts the "no leaching potential criteria," TCLP extraction and leachate analysis will be limited to 25 percent of the final set of soil sample collected.

The sampling procedure for each of the three sampling events are as follows. The pilot soil flushing area will be divided into four equal quadrangles of about 2,400 square feet each, as shown in Figure 3-4. In each quadrangle, samples will be collected with a hand auger at a minimum of six sampling points at two-foot intervals to a depth of six feet. At each sampling point in a quadrangle, a sample will also be collected from six feet to the water table, as necessary. All 0-2 foot samples in a quadrangle will be composited in a stainless steel or glass pan with the help of a stainless steel spoon. Similarly, all 2-4 foot, 4-6 foot, and 6 foot to water table samples within a quadrangle will also be composited. A maximum of four composite samples will be taken from each quadrangle, resulting in a maximum total of sixteen composite samples during each sampling event. These samples will be transferred to appropriate sampling containers and shipped for analysis.

Initial and subsequent soil sampling will be performed to the water table. Any analyses from beneath six feet will only be used to assess PCOC migration, not cleanup levels. If PCOCs should migrate to below the water table, the soluble compounds will be collected during remediation of the shallow aquifer.

Collection of the six subsamples and compositing them into one sample for each depth interval in each quadrangle is proposed due to the anticipated variability of soil constituent concentrations. It is expected that the three sampling events proposed (baseline, 3 months, 8 months) will provide meaningful data concerning the cPAH removal efficiency of soil flushing. A decision to continue pilot testing will be made based on results obtained from soil and recovery water analysis during the pilot test.

Random sampling will be used for the initial baseline evaluation. The locations of the six random sampling points in each quadrangle (60 ft. long x 40 ft. wide) will be

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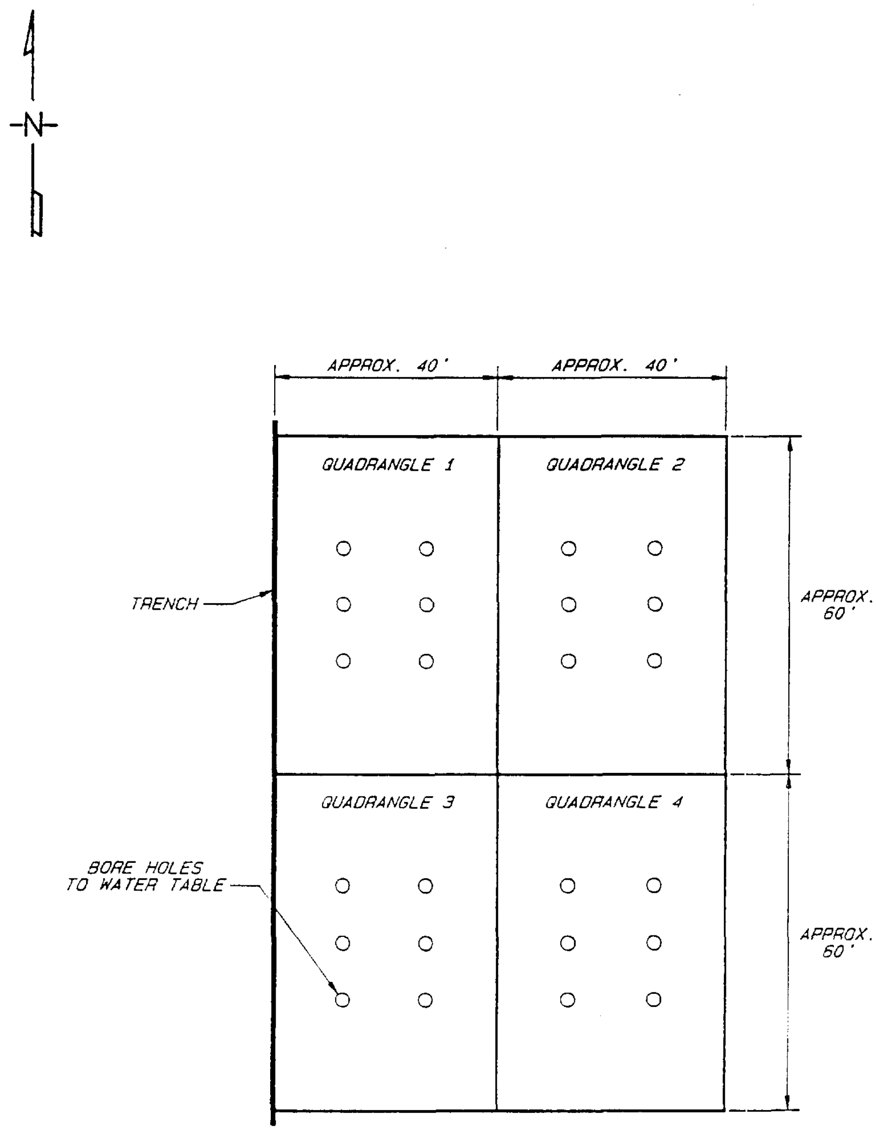

NOTE:

EXACT LOCATION OF SAMPLING BORE HOLES TO BE DETERMINED IN THE FIELD.

DRAWING NOT TO SCALE

KEYSTONE ENVIRONMENTAL RESOURCES, INC.

FIGURE 3-4

SOIL VERIFICATION SAMPLING LAYOUT FOR THE IN SITU SOIL FLUSHING AREA, SOUTH CAVALCADE SITE HOUSTON, TEXAS

8/5/91

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determined by selecting length and width coordinates from a random-number table. This will be done by indiscriminately choosing a page from the random number tables and then a column on that page. The width coordinates will be chosen by proceeding down the column and listing (at a minimum) the first six numbers that are greater than or equal to 0 but less than or equal to 40. The length coordinates will be chosen by listing (at the minimum) the subsequent six numbers that are greater than or equal to 0 but less than or equal to 60. Additional random grid points will be used if recovery lines or trenches are encountered. These sampling points will be marked by appropriate methods.

As stated before, the six subsamples obtained at each depth interval (0-2 feet, 2-4 feet, 4-6 feet, 6 feet to water table) will be composited to obtain a sample for each quadrangle. During the 3-month and 8-month sampling events, the same sampling locations used during the baseline evaluation will be used to collect the subsamples for compositing at each depth interval for each quadrangle. This is expected to reduce the variability associated with the sampling of non-homogeneous soils and provide a more realistic idea of the treatment efficiency achievable. The compositing procedure will be the same as described for baseline sampling. The individual data for total potentially carcinogenic PAH's obtained from each depth interval in each quadrangle, as well as the means of the at least four data points obtained at each depth interval in the four quadrangles will be evaluated to assess removal efficiency in the top six feet.

If either an individual sample data or the mean at a specific depth shows reduction of cPAH to below 700 ppm, the technology will be considered to be potentially capable of meeting this criteria. TCLP analysis will be conducted on the composite samples (see Table 3-3) collected after 8 months in the top 6 feet. The sampling locations for TCLP analysis will be based on results obtained during the 3-month sampling.

The 6 feet to water table sampling will be used to assess migration. The data obtained from this zone will not be used for comparison with the cleanup criteria. TCLP analysis will be conducted on the composite samples obtained at each of the three sampling events at the 6-foot to water table depth.

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The appropriate sampling procedures are described in Section 3.2 of the Sampling and Analysis Plan (SAP).

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4.0 EX SITU SOIL WASHING

The ROD issued for the South Cavalcade site includes soil washing as a recommended treatment technology. Pilot-scale soil washing studies will be performed to establish design criteria for the full-scale system.

Soil washing is a train of unit operations designed to decrease the volume of impacted soil by segregating the soil by particulate size and extracting/desorbing as much of the PCOC as possible into the liquid phase. The underlying principle behind the design of soil washing systems is that most PCOC are adsorbed to fine soil particles. In addition, PCOC adsorbed to larger soil particles can be desorbed into solution by various "washing" techniques. Separating the larger particles from the fine particles and washing the large particles with various solutions can result in "clean" soils. The fine fraction is handled appropriately after separation. The nature of the soil to be treated and the economics of fine particle handling determine whether medium particulate fractions are washed clean or handled with the fines. The liquid phase is treated in a separate operation.

4.1 Objectives of the Pilot Study

The objective of the pilot-scale testing will be to obtain quantitative data that can be used as the basis for design of the full-scale soil washing unit.

Specific objectives include:

- Confirm whether the soils at the South Cavalcade site can be washed to levels which achieve the treatment goals stipulated in the ROD and identified in Section 2.0.

- Determine the residence time necessary for extraction of PAH from the soil in a multistage soil washing system. This will translate into reactor size and throughput for the full-scale system.

- Determine the solid/liquid separation efficiency necessary to achieve high density washed soil slurry from each stage.

- Determine the volume of fines/froth that will be generated for disposal.

- Determine the dewatering rates for the fines/froth and for the washed soil.

- Confirm the quantity of washwater concentrate or blowdown which will be generated from the process

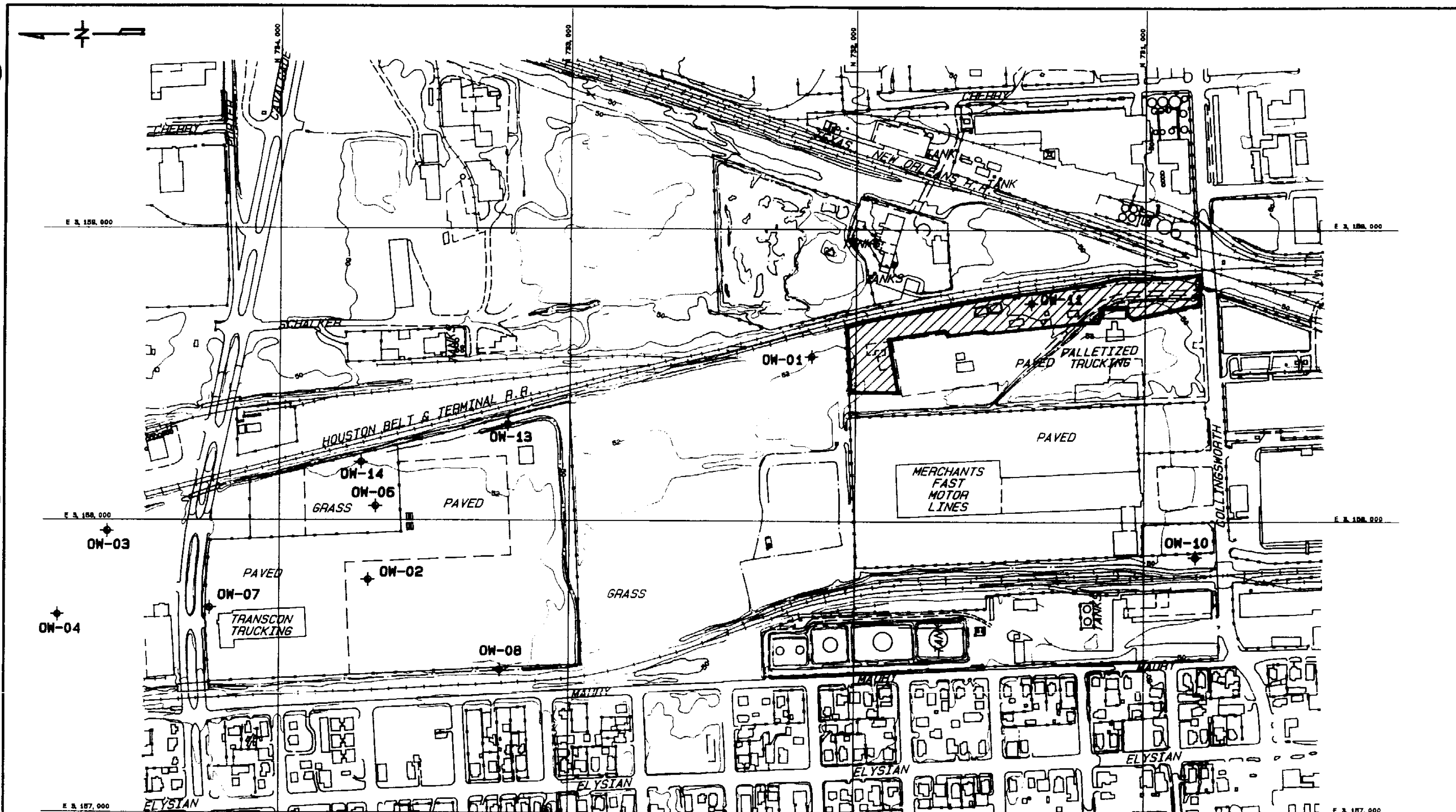
- Provide physical data on the washed soil to determine the compaction requirements.

4.2 Description of Soil to be Treated

The soil to be treated in the full-scale soil washing system consists of approximately 20,000 cubic yards located along the former drip track area (See Figure 4-1). The level of concentration of PCOCs in the soil in this area has not been well characterized to date. A grid sampling and analysis plan, defined in Section 3.1 of the SAP, will provide the necessary information to fill the data gaps prior to detailed design of the pilot soil washing system. In addition, Section 4.3 of this Work Plan defines additional tests which will insure that the information necessary for pilot system design is obtained.

For the pilot treatability study, soil will be collected in working batches of approximately 10 cubic yards each. Each batch will be a composite of the soils from the designated area. For testing purposes, variability in batch grain size and composition will be allowed to simulate the variable conditions expected during full-scale soil operation.

[redacted]



LEGEND

- AREA FOR PILOT SOIL WASHING SAMPLE COLLECTION

SCALE (FEET)
0 150 300

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FIGURE 4-1

APPROXIMATE LOCATION OF SAMPLES FOR SOIL WASHING

S. CAVALCADE SITE, HOUSTON, TX

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4.3 Predesign Evaluations

The design of the soil washing pilot system will incorporate physical and chemical data on the site soil. In addition to the information discussed in Section 4.2, the following predesign information will be useful for the detailed design of the pilot unit:

- Concentration of PCOCs vs grain size

  A representative sample of the soil is sieved to yield six fractions by particulate size (ASTM D 422). Each fraction is analyzed for PAH (EPA 8270). To obtain accurate particulate fractions, wet sieving will be utilized in the separation.

- Settling data vs particle fraction

  Particulate fractions from the sieving (ASTM D 422) are mixed with water and settling curves (time vs % settled) are developed.

This information will be obtained prior to design of the soil washing pilot system and is addressed in the SAP.

4.4 Pilot Unit Design

The pilot system will be designed to achieve the objectives outlined in Section 4.1. Pilot-scale testing will be performed to provide sufficient data to satisfy the data objectives outlined in Section 4.1. In general, the operation of the pilot unit will serve as a verification of system applicability and as a means of obtaining design data for full-scale system sizing.

4.4.1 Quantity of Soil to be Treated

The tests are expected to require the treatment of less than 100 cubic yards of soil. Steady state operation of the unit over a five-day period while generating soil that meets the target criteria will constitute successful operation. Parameters employed during this testing will provide information for system scale-up.

4.4.2 Critical Parameters

The pilot-scale testing will be performed so that the following design parameters can be determined.

- Extraction residence time,
- Settling residence time,
- Froth generation rate,
- Washwater generation rate,
- Dewatering characteristics of the treated soil,
- Concentrations of potentially carcinogenic PAH in the treated soil at steady state,
- Concentrations of potentially carcinogenic PAH in the froth at steady state,
- Concentrations of potentially carcinogenic PAH in the washwater at steady state, and
- Concentration of potential volatiles PAH emmisions from the froth unit.

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4.5 Pilot System Design and Construction

The objectives of the pilot system design will be to specify any modifications or additions that may be necessary to the soil washing pilot system. Utilizing data from the Remedial Investigation, the Feasibility Study Bench Scale Tests, and the predesign evaluations, the pilot system design will be modified for the treatment of the specific soil at the South Cavalcade site.

4.5.1 Hardware Design and Layout

A preliminary flow diagram is presented in Figure 4-2. The pilot system will incorporate the process techniques, chemistry, and sizing from the laboratory treatability testing in a larger scale system.

The Treatability Laboratory Report (Keystone, August 1988) outlines the procedures and results that are the basis of the pilot-scale design. The equipment utilized for the bench-scale testing was a Denver D-R flotation machine. Each final soil washing test employed two, 45-minute wash cycles, each consisting of a 15-minute mixing time followed by a 30-minute washing/foaming time. A 10-minute rinse cycle followed each wash cycle. The soil to water ratio used in all final runs was 1:5 (500 gm site soil and 2500 mls of tap water). Surfactants were employed to lower the surface free energy of the soil particles and enhance the solubility of the PAH in the liquid phase. A description of the results of the laboratory treatability study is included in Section 3.2.4.

The pilot unit will employ the same operational parameters as those employed on the bench-scale unit. The primary differences will be the size of the equipment and the fact that the various process stages will take place in individual vessels. Screening will be employed as a first stage of the process. Vegetation and other organic fractions which may meet the cleanup levels will also be removed at this stage. After the soil has been screened to remove debris and particulate sizes unsuitable for washing, the screened soil will be transferred to a mixing vessel for a 15-minute period. Here the soil will be mixed with water containing surfactant and NaOH in the same dosage range used for the bench-scale operations. The soil will

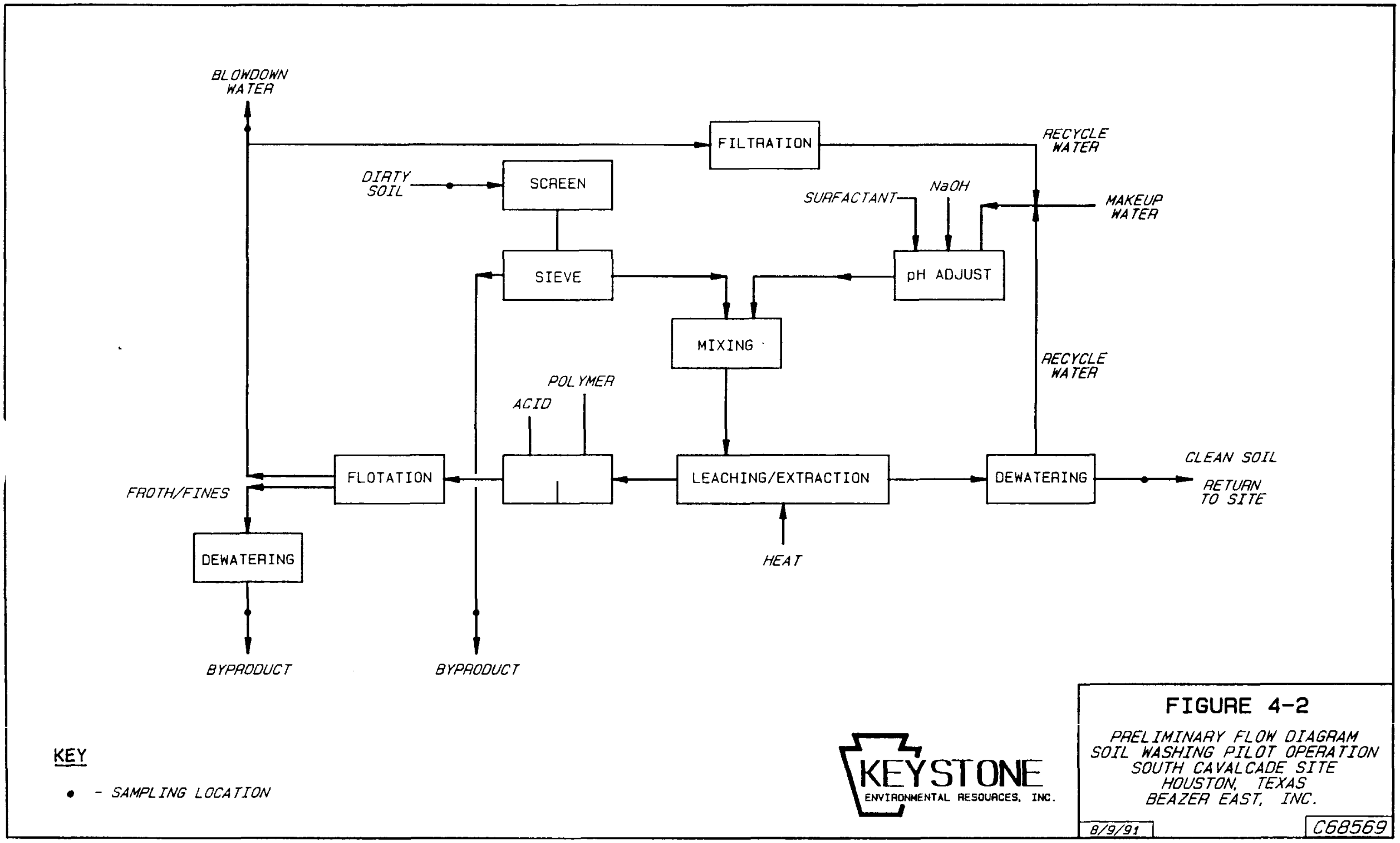

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FIGURE 4-2

PRELIMINARY FLOW DIAGRAM
SOIL WASHING PILOT OPERATION
SOUTH CAVALCADE SITE
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then be transferred to leaching/extraction vessels for a 30-minute wash period. Rinsing will be performed for at least 10 minutes following the wash cycle. The mixing, washing, and rinsing cycles will take place in countercurrent leaching/extraction chambers similar to those used for mineral extraction in the mining industry. Utilizing this equipment will greatly reduce the rinse water consumption and allow a large percentage of this water to be recycled.

Flotation will be performed in a chamber designed for this purpose. The overflow from this unit process will be a froth containing some soil fines and the majority of the PCOC. The froth stream will be discharged for disposal. The underflow from the flotation process will be filtered, and adjusted for pH and/or polymer. A small portion of this flow will be transferred to a holding tank for processing by the water treatment system. The majority of the underflow will be filtered, pH adjusted, and/or polymer adjusted and returned to the leaching extraction chambers as rinse water.

Soil washed in the leaching/extraction chambers will be transferred to a dewatering operation employing filter presses. After dewatering, the soil will be transferred to a lined holding pad for sampling.

4.5.2 Assembly

The majority of the pilot system components will arrive at the site mounted on two, 40-foot tractor trailers. Some rough screening and dewatering equipment will be free standing. Other components will be modular in nature and will need only minor piping connections made at the site.

4.5.3 Pads and Containment

Referring to the preliminary layout sketch, Figure 4-3:

- Storage pads for holding bins containing clean and raw soil will be needed. These will be approximately 25 feet x 25 feet each. The pads will be bermed to control runon and runoff. Any accumulated water

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[redacted]

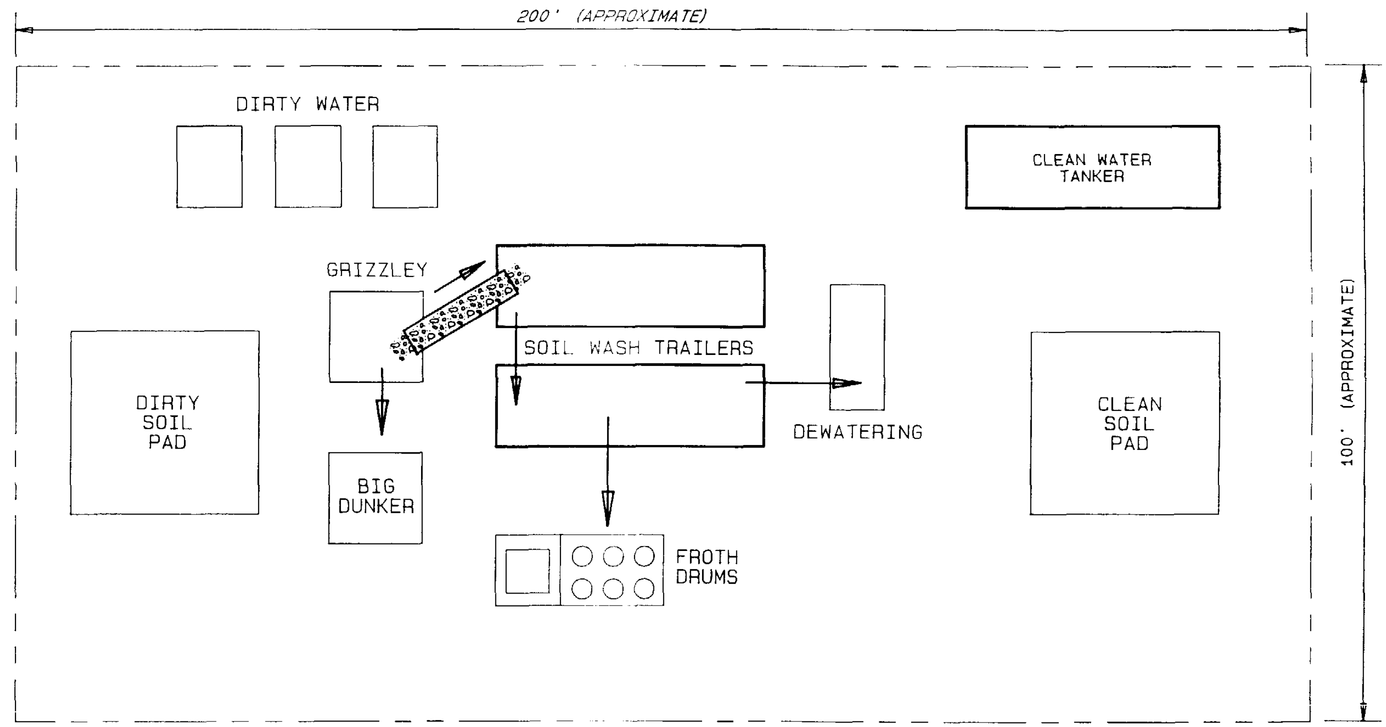

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FIGURE 4-3

PRELIMINARY LAYOUT
SOIL WASHING PILOT OPERATION
SOUTH CAVALCADE SITE
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will be sent to the water treatment system. The pads will also be lined to minimize the potential for PCOC migration to the soils underlying the pad.

- The pilot equipment will be left on the trailers for the duration of the pilot test. The trailers do not incorporate secondary containment.

- Portable storage tanks will be utilized for primary storage of the effluent washwater.

- The froth drum containment area will also be bermed and lined to prevent water runoff. Froth will be stored in this area prior to treatment.

4.5.4 Enclosure

The system would not be enclosed. However runon/runoff control will be incorporated into the necessary areas as discussed in Section 4.5.3.

4.5.5 Utilities

Electricity

The pilot unit will require 220 volt electrical service. In addition, the screening and dewatering equipment will require 220 volt service. If this quantity of electricity is not available a generator can be rented.

Water

Treated water from the pilot-scale water treatment unit will be used to supply the soil washing pilot system; however, if an insufficient volume of treated water is available, tap water will be used. Water will be drinking water supplied by a tank truck from a commercially available source.

Heat

The pilot unit will be operated at a temperature above 40 degrees Centigrade. Heat will be electrically supplied to the pilot system.

4.6 Pilot System Operation

4.6.1 Soil Collection

It is expected that the soil washing pilot test will process less than 100 cubic yards of soil during the entire testing phase. To streamline operations and testing, the soil will be collected, stockpiled and washed in batches of 10 cubic yards each.

Soils will be collected from the site based on the results of the grid sampling program described in Section 3.1 of the SAP. A range of soils will be tested, from those soils showing the highest concentrations of total potentially cPAH to those soils with concentrations just above the remedial goals. To ensure that a range of soils is being tested in the pilot unit, influent soil samples will be collected and analyzed before the soil is washed.

4.6.2 Startup

Initially the mixing, flotation, and settling vessels will be filled with treated water or tap water. The pilot system, and screening and conveying equipment will be started and discharge valves will be closed so that the unit is operating in a full recycle mode.

Soil will be lifted by front-end loader into the inlet of the gross screened chamber where it will be transported by conveyor to the soil washing system. The feed rate will be maintained at a small percentage of total capacity until sufficient soil has entered the system to bring all chambers to near equilibrium. A determination of equilibrium will be based on physical parameters.

As the system approaches steady-state, the surfactant feed pump will be started, and discharge valves will be opened gradually. Clean makeup water will be added automatically to compensate for volume lost through discharge of water to the pilot water treatment unit.

4.6.3 Operation

The system will be operated at conditions similar to the bench scale to determine if the extraction rates previously observed in a small batch mode are valid for full-scale operation.

4.6.3.1 Extraction Residence Time Determination

An important design parameter for the soil washing system is the extraction residence time to achieve a soil with less than 700 mg/kg total potentially carcinogenic PAH and "no leaching potential criteria" as described in Section 3.1.1 of the SAP. Bench-scale soil washing tests have obtained positive results with a residence time of 45 minutes; therefore, the pilot system initially incorporates an extraction step with a 45-minute residence time. Should the results of the pilot test show that the extraction time is longer or shorter than necessary, the full-scale unit can be designed accordingly.

4.6.3.2 Confirmation of Overall System Performance

The pilot unit will be operated and optimized based on the conditions which proved effective during bench-scale testing. Washed soil will be sampled and analyzed for PAH. Samples will be collected every two hours and composited daily, to ensure that all soil fraction s are represented. If the analytical results show total potentially carcinogenic PAH concentrations in the range of 400-650 mg/kg and meet the "no leaching potential criteria," the full-scale system will be designed to be similar to the pilot unit. If total potentially carcinogenic PAH concentrations in the washed soil are in the range of 200-400 mg/kg, a second run at twice the throughput will be performed to test for the potential to downsize on the full scale. If the concentration is above 700 mg/kg, a second run will be made at half the initial flow.

These effluent concentration ranges were chosen to ensure the system can achieve the remedial goals with a certain factor of safety, while still treating at an optimum rate.

4.6.3.3 Determination of Solid/Liquid Separation

Visual observations of the vessels will determine if adequate residence time is being allowed for solid-liquid separation at each stage. Settling tests will be performed on the supernatant. A supernatant with less than 5% settleable solids will be considered acceptable for the full-scale design. Flow through the system will be adjusted to give 2% to 5% solids, and the residence time necessary to achieve this will be recorded for full-scale design purposes.

4.6.3.4 Determination of Fine/Froth Generation

After the system has been operated at various throughputs and a flow/residence time has been chosen, the pilot unit will be operated for a five-day period at steady state to generate soil below the target levels. The volume of fines/froth generated during this period will be considered characteristic of the full-scale system. This volume will be recorded and used to calculate a froth generation rate in terms of a dry weight percent of untreated soil. The method for measuring the froth volume will be determined during the detailed pilot design phase.

4.6.3.5 Determination of Dewatering Characteristics

The washed soil will be filtered to determine rate and efficiency of dewatering. This information will determine the type and size of dewatering equipment needed for the full-scale system.

4.6.3.6 Washwater Generation Rate

During the same five-day period used to determine the fines generation rate, the quantity of washwater will be measured and recorded. Also, washwater generation rates will be averaged for a longer period of approximately one month after system stabilization to give a more representative determination of the wash water generation rate over time.

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4.6.3.7 Physical/Construction Data on Washed Soil

After washed soil has been shown to meet remedial goals, it will be stockpiled on site. One composite sample will be obtained and tested to determine the moisture density relationship in accordance with the Standard Proctor Method (ASTM D 698) or relative density (ASTM D 4253 and ASTM D 4254). The results of this test will determine the density required for placement on site. One, 50 pound sample will be required.

4.6.4 Treated Soil Handling

Treated soil will be stored in holding bins on a lined pad until the protocol for returning the soil to the site is established. The soil will then be placed back on the site in a designated "clean" area.

4.6.5 Byproduct Handling

Byproducts of the soil washing operation may consist of the following:

- Large chunks of asphalt-like material not meeting cleanup goals or criteria,
- Large chunks of concrete from old pads and foundations, and
- Froth/fines containing concentrations of PCOC above the cleanup goals.

Any byproducts produced during soil washing will be managed in an appropriate manner.

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4.6.6 Demobilization

Upon completion of the soil wash pilot test, the unit will be demobilized in the following manner:

- Residual soil will be cycled through the system until all soil meets cleanup goals or is discarded with the froth.

- Water will be drained from the system through the discharge lines of the solids pumps, which will be temporarily piped into the water discharge lines. The water will be discharged into the effluent holding tanks to be processed by the pilot water treatment system.

- Fresh water will be pumped into the system and the system operated in full recycle mode for a period until the unit is visibly free of soil.

- The fresh water will be pumped from the system into the effluent holding tank.

- Tanks, trailers and equipment will be blasted with hot water until they are free of visible soil. The clean soil pad may be used as the decontamination area. Water from decontamination operations will be processed by the pilot water treatment system.

- The soil washing system and auxiliary equipment will be removed from the site leaving the site in generally the same or better condition than it was prior to the pilot project.

- Pumps and tanks will be decontaminated as integral part of the soil washing unit.

- Liners will be removed with the pilot equipment. Pads and berms will be left at the site for possible use during the full-scale operation. Site grading should not be required.

4.7 Performance Testing

Samples collected and analyzed as part of the soil washing pilot study fall into three categories:

- Soil pile,
- Operational, and
- Mass balance performance test.

4.7.1 Soil Pile Sample Collection

Soil to be treated will be excavated in 10 cubic yard batches and stored in holding bins of approximately 15 cubic yard volume. Coring tubes will be used to bore into the soil and collect samples at nine locations. THese subsamples will be composited at random to yield three samples for analysis. See Section 5.3.1 of the SAP for these procedures and the Health and Safety Plan for personnel protection requirements. The composite samples will be analyzed for potentially cPAH by Method SW 8270.

4.7.2 Operational Sample Collection

4.7.2.1 Flotation Cell Operational Sampling

During the flotation cell fine-tuning, water and froth samples will be collected to insure that the constituents of concern are leaving the cell in the froth, not in the underflow. The specific concentration of potentially cPAH in the underflow and froth should be known before mass balance runs are performed.

Froth and effluent water samples will be collected by grab sampling event two hours and composited on a daily basis. This sampling will only be performed when the unit is in a production mode, after start up is complete. Underflow samples will be collected via a sample tap located beneath the froth.

4.7.2.2 Clean Soil Operational Sampling

Operational adjustments to the solids flow will be verified by periodic sampling and analysis of the clean soil. During operational testing, clean soil will be stored in holding bins of approximately 15 cubic yard volume. Coring tubes will be used to bore into the collected soil and collect samples at nine locations. These subsamples will be composited at random to yield three samples for analysis. See Section 5.3.1 of the SAP for more detailed procedures and the Health and Safety Plan for personnel protection requirements.

The composite samples will be analyzed for PAH by EPA 8270, and samples will be subjected to TCLP and PAH (EPA 8270) analysis of the leachate. If correlation studies determine that the OLM adequately predicts the "no leaching potential criteria," TCLP extraction and leachate analysis will be limited to 25 percent of the final set of samples collected. The specific concentration of PAH in the clean soil should be known before mass balance runs are performed.

4.7.3 Mass Balance Performance Test Sample Collection

At the end of the mass balance performance test run, samples will be collected at the following points:

- froth outlet,
- clean soil outlet, and
- washwater outlet.

Samples will be collected every two hours and composited on a daily basis for the duration of the five-day performance run. See Section 5.3.1 of the SAP and SOP 205 and 304 of Appendix A of the SAP for more detail. Each composite sample will be analyzed for total potentially cPAH by Method SW 8270 for both soils and water.

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4.8 Reports

4.8.1 Detailed Design Report

Prior to the pilot testing, unit drawings and specifications will be provided. Specific deliverables for the detailed design of the soil washing study will be:

1.) Equipment and Construction Specifications

2.) Process Description

3.) Drawings

Process Flow Diagram
General Equipment Layout
One Shop Drawing of each major piece of equipment
Process and Instrumentation Diagram (P & ID)
Piping Drawing, Plan View
Single Line Electrical Drawing
P & ID Legend

4.) Experimental Plan and Procedures

Parameters to be tested
Procedures for operation of the pilot system
Procedures for optimizing system performances
Operational sampling and analysis
Measurement and determination of design parameters

5.) Detailed Schedule

6.) Management and Staffing Plan

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These deliverables will be assembled into a detailed work plan and design document.

4.8.2 Summary Evaluation and Report

At the completion of the pilot testing, a Report of Findings will be completed. The report will present, discuss, and evaluate the data obtained to support design of the full-scale soil washing system. Recommendations will be provided for the design and construction of the soil washing system, if appropriate. The report will include at a minimum the following information:

- Objectives and design criteria,
- Summary of soil washing pilot testing,
- Results and summary of test data, and
- Recommendations for design, construction, and operation of the full-scale soil washing system.

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5.0 WATER TREATMENT SYSTEM PILOT STUDIES

The ROD issued for the South Cavalcade site requires that groundwater remediation will consist of pretreatment, followed by filtration and activated carbon adsorption. Pilot-scale testing will be conducted to confirm the effectiveness of the technologies and to obtain design information for a full-scale system. The treated water will be discharged to the above grade portion of the in situ soil flushing system and the soil washing unit, with excess treated water discharged to the Little Whiteoak Bayou via NPDES permit. Additional water which will be treated in this system includes water collected from the in situ soil flushing pilot system and washwater from the soil washing pilot system.

5.1 Objectives of Pilot Water Treatment Studies

The objectives of the water treatment system pilot studies are: (i) to obtain quantitative performance data for the selected technologies in relation to the discharge and/or groundwater recharge standards, (ii) to demonstrate the effectiveness of selected technologies to treat the water streams generated at the site, and (iii) to develop data necessary for design of the full-scale water treatment system at the site.

Specific objectives of the pilot studies are as follows:

- Evaluation of pretreatment processes such as gravity settling, pH adjustment, polymer addition/flocculation, and granular media filtration for removal of free and emulsified oils and suspended solids;

- Evaluation of effluent quality achievable via carbon adsorption and development of carbon usage rates;

- Evaluation of the fluidized bed treatment system to:

    a. Evaluate the applicability of this technology for site water treatment,

b. determine the effluent quality attainable,
c. evaluate the effect of varying the loading rate on process performance, and
d. develop data necessary for full-scale design and costing.

- Evaluation of surfactant addition equipment and dosage rates for the in situ soil flushing recharge water; and

- Development of information required to evaluate options for recycling or disposal of non-aqueous phase liquids (NAPLs).

The target treatment standards or goals to be achieved during the pilot water treatment studies for (a) surface water discharge of excess treated effluent (water not re-injected) to the drainage ditch leading to the Little Whiteoak Bayou, and (b) subsurface discharge of treated effluent for groundwater recharge during the in situ soil flushing studies, are outlined in Section 2.0.

5.2 Sources and Estimated Volume of Water to be Treated

The sources of water expected to be treated in the water treatment pilot system include, (a) the groundwater pumped during the groundwater extraction well pilot test, (b) the wash/rinse water as well as any dewatering water generated during the ex situ soil washing pilot test, and (c) water recovered from the trench drain system during the in situ soil flushing pilot test. Note that in the following discussion, details such as storage tank dimensions; measures for containing or preventing storage tank leaks; conveyance system descriptions such as pipe diameter, material, length, etc.; pump size and model; interconnecting piping details; and tank truck size; will be provided as part of the detailed design package.

5.2.1 Extraction Well Pilot Test

During the groundwater recovery pilot test, one intermediate test well (ITW-02) and one shallow test well (STW-02) in the southern portion of the site, and one intermediate test well (ITW-01) in the northern portion of the site are each expected to be pumped for at least 72 hours. The approximate location of each test well is indicated in Figure 3-1. The pumping rate to be used in these tests is approximately 1.25 gpm. The proposed pumping rate is a preliminary estimate and is expected to be finalized/refined prior to the tests. The final pumping rate(s) used is not expected to significantly impact the design of the pilot water treatment system. It is expected that these pump tests will be conducted before the in situ soil flushing pilot test to prevent the influence of one test on the other. The total quantity of water estimated to be generated during the extraction well pilot test is shown in Table 5-1. This water will be stored in appropriate storage tanks in the northern and southern portions of the site until it is transferred to the water treatment pilot system located in the central portion of the site. At this time, 3,000 - 5,000 gallon tanker trucks are expected to be used.

5.2.2 In Situ Soil Flushing Pilot Test

During the in situ soil flushing pilot test, groundwater will be recovered from the test trench drain system at an estimated rate of 1 - 4 gpm. It is expected that this pilot test will run for a period of about eight months, although the exact duration of this study will be determined in the field. This system will run on a continuous basis except for temporary shut down periods for maintenance. The total quantity of water estimated to be generated from the pilot test during the eight-month operating period is shown in Table 5-1. This water will be directly pumped from the trench drain system to the water treatment pilot system located about 450-500 yards away at the center of the site.

5.2.3 Ex Situ Soil Washing Pilot Test

The ex situ soil washing pilot test will generate water from soil washing, rinsing and dewatering operations. This water will be stored in the vicinity of the soil washing pilot unit and transferred periodically to a storage tank located at the head of the water treatment pilot system. The estimated rate of water discharge from the soil washing pilot system is about 1-200 gpd. This will be refined after the data gaps are filled. Based on a three-month operation period, the total quantity of water estimated to be generated from the soil washing pilot system is shown in Table 5-1.

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TABLE 5-1

ESTIMATED VOLUME OF WATER FOR TREATMENT

Source		Estimated Maximum Volume of Water (gals)
(a)	Extraction Well Pilot Test	
	Southern Area	10,800
	Northern Area	5,400
	Total	16,200
(b)	In Situ Soil Flushing Pilot Test (1)	1,382,400
(c)	Soil Washing Pilot Test (2)	18,000

(1) Assumes an eight-month operating period with 24-hr/day operation.
(2) Assumes a three-month operating period with eight-hr/day operation.

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The soil washing pilot system is expected to be located close to the water treatment pilot system and soil wash/rinse water can be transferred by tank truck or by means of pipe to the water treatment storage tank.

5.3 Summary of Previous Laboratory Treatability Studies

5.3.1 Preliminary Treatability Results

Preliminary treatability investigations were performed by Keystone on groundwater samples collected in November 1987. Detailed descriptions of these investigations can be found in "Appendix A - Treatability Laboratory Report, Feasibility Study, South Cavalcade Site, Houston, Texas, August 1988." The following is a brief description of relevant parts of the study.

Seven, 55-gallon drums of water were collected from observation wells OW-11 and OW-10, located at the southern end of the site, in the former process area. These are shallow zone monitoring wells. Two composite samples were taken from these drums, one at the site (November 18, 1987), and the other at Keystone's Monroeville labs (December 10, 1987) and analyzed for PCOC. Selected results are shown in Table 5-2. These two wells were apparently chosen for sampling during the treatability testing due to the levels of PAH or aromatic volatile organic compounds observed in the well water during the RI.

There are differences between these results and the "maximum" groundwater concentration of constituents as described in Table 2 of the Record of Decision (ROD). The groundwater sampling locations for the treatability work were selected on the basis of all the available data from the RI, and are expected to be reasonably representative of site groundwater characteristics. "Maximum" concentrations of groundwater constituents are typically not representative of overall site conditions. Since the pilot water treatment system is expected to treat water from pump tests, in situ soil flushing and soil washing, additional laboratory treatability studies are proposed with these types of surfactant-containing water as described in Section 5.3.2. The previous treatability studies are briefly described below.

TABLE 5-2

SELECTED ANALYTICAL RESULTS
GROUNDWATER LAB TREATABILITY TESTING

Parameters (mg/l)	On-Site Sample 11/18/87	Laboratory Sample 12/10/87	Maximum Groundwater Concentrations (1)
Biochemical Oxygen Demand (BOD)	325	255	
Chemical Oxygen Demand (COD)	580	768	
Oil and Grease (O&G)	113	144	
Total Organic Carbon (TOC)	63.4	59.8	
pH (Standard Units)	7.2	7.4	
Total Recoverable Phenolics (as Phenol)	8.31	7.82	
Total Polynuclear Aromatic Hydrocarbons (PAHs)	71.4	39.2	21,950
Arsenic (As)	0.0117	0.0154	0.522
Lead (Pb)	0.0062	<0.005	0.260
Naphthalene	35.6	11.6	7,100

(1) Per Record of Decision (ROD), South Cavalcade Site, Houston, Texas, September 1988.

Simple gravity settling of the water for 24 hours in a five-gallon glass jar resulted in a clearing of the water with an oil sheen on top and a heavy 1/2" settled layer at the bottom. Gravity settling brought about an 86 percent reduction in oil and grease, 70 percent reduction in methylene chloride extractables, 1.3 percent reduction in phenolics, and 73 percent reduction in PAH concentrations. These parameters, with the exception of methylene chloride extractables (which is not expected to provide any additional useful information) will be evaluated in the pilot program (See Section 5.4.4).

Oil/water separation using polymer addition in standard jar tests was also evaluated. Two combinations of Drew Chemical Company's polymers successfully flocculated the oil phase in the groundwater into a dense, stable settled material, and these were:

Amerfloc 10 @ 300 ppm
Amerfloc 5260 @ 4 ppm
and
Amerfloc 10 @ 300 ppm
Amerfloc 5270 @ 4 ppm

The volume of wet settled material generated from these two polymer tests was 11.2 gallons per 1,000 gallons of groundwater (1.12 percent). This corresponded to a dry weight (dried at 103^{o}C) generation of 0.07 pounds per 1,000 gallons of groundwater treated by polymer. Polymer treatment achieved 90 percent oil and grease removal, 79 percent methylene chloride extractables removal and 0.3 percent removal of TOC based on raw water concentrations. Phenolics and PAH removals were not reported.

Polymer addition for oil/water separation of the treatability study groundwater sample was not deemed necessary due to the only slightly better removal rates and added cost of polymers; however, if the nature of the in situ groundwater is different from that sampled for treatability, addition of polymers may be necessary for oil/water separation. The preliminary polymer-treated settling test produced a settled material which was apparently too dilute and too low in creosote oil concentration to make a direct product recovery possible from the settled material alone.

To evaluate the feasibility of treating site groundwater with activated carbon, carbon isotherm testing was performed on gravity-settled site groundwater. Calgon Corporation's F-300 granular activated carbon, pulverized so that 95 wt % passed through a 325 mesh screen, was used and standard testing was performed with one-hour contact time. The estimated carbon usage rates were derived from the carbon isotherm plots presented in Appendix nine of the treatability report, and are presented in Table 5-3.

An Accelerated Column Test (ACT) was also performed by Calgon Corporation on a sample of site groundwater provided by Keystone to further evaluate the feasibility of carbon adsorption. The ACT used F-300 granular activated carbon and simulated a carbon column system. Since no projected flow estimate of pumped groundwater or permit limits were available at the time of the treatability work, a 15 minute empty bed contact time was used with example treatment objectives of 30 ppm TOC, 0.5 ppm phenols and 0.5 ppm naphthalene. The estimated carbon usage rates based on the ACT are also presented in Table 5-3. Except for the carbon usage rate for phenol, the data obtained by Keystone and Calgon appeared to be in agreement. The results of the ACT indicated that phenolics would be the limiting compound, although the initial naphthalene concentration was much lower than anticipated. The ACT study also recommended that the water be filtered for solids removal prior to treatment.

5.3.2 Applicability of Data to Pilot Study and Additional Data Requirements

Even though the preliminary gravity settling treatability test showed that oil/water phase separation is possible by physical means alone, a secondary oil/water separation phase using pH adjustment and polymer addition may be required during pilot testing to remove emulsified oils. The site groundwater sample used for the laboratory treatability tests contained about 113-144 mg/l of oil and grease. Recovery of dense non-aqueous phase liquids observed at several wells could

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TABLE 5-3

ESTIMATED CARBON USAGE RATES FROM TREATABILITY STUDIES

Study	Basis (Influent Conc., mg/l)	Carbon Usage (pounds/1,000 gals. water)
1. Keystone Laboratory Carbon Isotherm Study	Naphthalene (2.74)	0.99
	Phenol (7.45)	4.4
	TOC (56)	2.33
2. Calgon ACT Test	Napththalene (0.335)	1.0
	Phenol (5.3)	2.75
	TOC (58)	2.5

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potentially occur, requiring phase separation from the water before treatment of the water. The presence of surfactants in the water recovered from the in situ soil flushing pilot system and in the water discharged from the ex situ soil washing pilot system may also change the characteristics of the influent to the water treatment system. The impact of any changes in the treatment system influent characteristics on oil/water phase separation, will be evaluated during the pilot tests. In addition, laboratory settling tests will be performed to evaluate pretreatment requirements for the surfactant-containing water. Non-aqueous phase oils and solids generated during the pilot studies will be stored on site and information required to evaluate reuse/disposal options will be developed.

Since the previous treatability studies were conducted with groundwater and the pilot water treatment system is expected to treat not only groundwater from the pump test but also water containing surfactants from the pilot in situ soil flushing and pilot soil washing system, additional treatability studies are proposed. These are described below.

Prior to start up of the pilot test, simple gravity settling and polymer treatment of a water sample containing groundwater mixed with the selected surfactants or soil wash water, will be evaluated. The procedure used for the gravity settling test will be similar to that described in the previous laboratory treatability report. The raw water sample and the supernatent from the jar test will be analyzed for parameters such as oil and grease, TOC and pH. The supernatent from the gravity settling test will be used in polymer treatment jar tests to determine the need and dosage rates for polymers. Again, the procedure used will be similar to the previous laboratory polymer tests and the polymers found effective during the previous studies will be further tested. The supernatent will be analyzed for oil and grease, TOC and pH. The volume of the settleable oils and solids generated during the gravity settling and polymer treatment tests will be recorded.

The activated carbon treatability testing conducted by Keystone and Calgon was performed on samples of gravity-settled groundwater obtained from wells OW-11 and OW-10. During the pilot studies, the water to be treated will be obtained not only from groundwater extraction wells, but also from in situ soil flushing and ex situ soil washing activities. The water streams obtained from the in situ soil flushing and ex situ soil washing activities are expected to contain surfactants and detectable concentrations of PCOC that were transferred from the soil (solid) phase to the water phase. While surfactants are used advantageously in separating the PCOC from the soil in soil flushing/washing, they may be detrimental to the operation of the activated carbon adsorption system. Surfactants solubilize PCOC while carbon is most effective on compounds with limited solubility. Also, surfactants may use up some of the adsorptive capacity of the carbon which would otherwise be available to the PCOC. Based on these considerations and the fact that the concentrations of PCOC in the treatment plant influent can also be potentially higher than that contained in the samples used for the laboratory treatability studies (see Table 5-2), the results obtained in the laboratory studies for carbon adsorption may not be directly applicable to the pilot-scale carbon adsorption system.

The pilot-scale study will evaluate the performance of the carbon adsorption system for treating the groundwater mixed with soil flushing/washing water. An additional laboratory carbon isotherm testing will be performed before start up of the pilot studies on a settled water sample containing groundwater mixed with the selected surfactants or with soil wash water (containing surfactants) to better simulate the actual field conditions during the pilot study. The results of the study will be used to modify the pilot system, if necessary.

The procedure used for conducting the laboratory carbon isotherm testing will be similar to that described in the previous laboratory treatability report. Different weight ratios of activated carbon will be added to a fixed volume of settled groundwater. Gravity-settled and/or polymer-settled water from the pretreatment studies will be evaluated for the carbon isotherm test. One test with no carbon added will serve as the control test. The carbon/groundwater slurries will be contacted for an hour, and the liquid will be separated from the carbon by filtering. The liquid phase will be analyzed for TOC, naphthalene, total recoverable phenols, and pH. The isotherm data will be evaluated graphically to estimate carbon usage rates. Appropriate samples of the carbon treated water from the isotherm studies will be adjusted to pH 9-10 using liquid sodium hydroxide to get an estimate of the

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amount of NaOH that may be necessary to adjust the pH of the treatment plant effluent to be used in situ soil flushing (See Section 5.4.10). 009444

An upflow, aerobic, fluidized bed reactor will be used in the pilot study; however, this treatment system was not evaluated in the previous laboratory treatability studies. Soil column studies for in situ bioremediation and slurry (soil plus groundwater) reactor studies for biological treatment were investigated as part of the previous laboratory studies. Although these studies showed some PAH biodegradation, the results are not directly applicable to the treatment of the surfactant-containing groundwater in the fluidized bed system. Information required to evaluate the feasibility and effluent quality achievable with the fluidized bed system will be developed in the pilot study. Preliminary design criteria for the fluidized bed reactor are presented in Table 5-4 (Item 11). Detailed design information will be presented in the detailed design package.

A laboratory study for the fluidized bed reactor is not considered to be necessary since 1.) the surfactant-containing influent water used in the pilot studies will be more representative of field conditions and hence the data on removal efficiency and effluent quality will also be more representative, 2.) the data obtained from the larger pilot unit used (feed rate approximately 0.2 gpm) will be more reliable in scaling up to a full scale system than a small laboratory unit (typical feed rate of 10-15 ml minute), and 3.) the duration of the pilot study (approximately 4-6 months) will also produce more realistic information on constituent removal than a short term laboratory study (typically about 8-9 weeks duration). A laboratory study would also require shipment of a large volume of water for testing.

The fluidized bed reactor technology has been evaluated for treatment of groundwater impacted with PAH, pentachlorophenol, etc. on laboratory and pilot-scale at other wood treating sites (Keystone, February 1988; Rosenbaum and Gromicko, June 1990). Since the feasibility of the fluidized bed reactor will be evaluated on a side stream from the multi-media filter, the routine operation of the main stream processes will not be affected.

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TABLE 5-4

PRELIMINARY DESIGN CRITERIA FOR PILOT WATER TREATMENT SYSTEM

1. Estimated Influent Flow Rate:

Sources	Estimated Flow Rate (gpm) Minimum	Maximum	Expected Duration
(a) Recovery water from pilot in situ soil flushing system	1	4	Depends on performance. Expected to be about eight month
(b) Wastewater from pilot ex situ soil flushing system*	0.002	0.417	2-3 months.
(c) Groundwater from extraction well pilot test	1.25 (or less)	2.5**	Each of the three wells will be pump tested for at least 72 hours, resulting in a total of about 9 pumping days.
Total	2.25 (or less)	6.92	

2. Estimated Effluent Reuse Rate:

Pilot Systems	Estimated Flow Rate (gpm) Minimum	Maximum
(a) Recharge water for pilot in situ soil flushing system	N/A***	2
(b) Requirements for pilot ex situ soil washing system	0.002	0.417
Total	N/A	2.4

3. Equipment Design Basis:
A design flow of 10 gpm selected to accommodate the maximum estimated flow rate of 6.9 gpm with a safety factor of about 1.5.

4. Soil Washing Wastewater Storage Tank:
Existing site fiberglass tank
Tank volume 5,000 gal.
Provisions for oil/solids removal

* Assumes an eight-hour shift per day.
** Assumes that the two intermediate test wells (ITW-01 and ITW-02) will be pump tested at the same time.
*** N/A = Not Available

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TABLE 5-4 (Cont.)

PRELIMINARY DESIGN CRITERIA FOR PILOT WATER TREATMENT SYSTEM

5. Groundwater Storage Tank:	
Existing site fiberglass tank	
Tank volume	8,000 gal.
Provisions for oil/solids removal	
6. Soil Flushing Recovery Water Storage Tank:	
Existing site fiberglass tank	
Tank volume	8,000 gal.
Provisions for oil/solids removal	
7. Product/Solids Storage Tank:	
Exact quantity of settleable oils and solids produced not known	
Proposed tank volume	5,000 gal.
8. Oil/Water Separation Unit:	
Design flow	10 gpm
pH adjustment compartment	
Provisions for mixing and acid/base addition	
Approximate residence time	5 minutes
Polymer mix compartment	
Provisions for mixing and polymer addition	
Cationic and anionic polymer	
Approximate residence time	2 minutes
Flocculation compartment	
Provisions for slow mixing	
Approximate residence time	20 minutes
Oil/solids separation unit	
Gravity solids settling	
Approximate residence time	30-60 minutes
9. Multi-Media Pressure Filter:	
Design flow	10 gpm
Number of filter units	1
Filtration rate	5 gpm/sq.ft. (maximum)
Backwashable	
Approximate backwash rate	40-50 gpm
Backwash water source: plant effluent or tap water	
Backwash water discharged to soil washing wastewater storage tank	

TABLE 5-4 (Cont.)

PRELIMINARY DESIGN CRITERIA FOR PILOT
WATER TREATMENT SYSTEM

10. Activated Carbon System:		
Design flow	10 gpm	
Number of vessels or units	2 in series	
Estimated carbon usage rate based on lab treatability study determination:	2.5–2.75	lbs/1,000 gal.*
Estimated total carbon usage based on Table 5–1 total volume of water:	3500–4000	lbs*
Total empty bed contact time (2 units)	60–110 minutes	(minimum)*
Backwashable		
Approximate backwash rate	65–175 gpm	
Backwash water source: plant effluent or tap water		
Backwash water discharged to soil washing wastewater tank		

* Will be refined based on proposed laboratory carbon isotherm test.

11. Fluidized Bed Reactor System (BiFar)		
Influent tank		
Volume	55 gal.	
Provisions for acid, base and nutrient addition		
Reaction biotank		
Diameter	6 inches	
Height	12 feet	
Material	304	Stainless Steel
Design flow (feed)	0.2 gpm	(maximum)
Carbon expansion	25–30%	
Recycle tank		
Volume	30 gal.	
Effluent tank		
Volume	30 gal.	
12. Effluent Storage Tank		
Tank volume: design to store about 1 day flow at design flow rate of 10 gpm	15,000 gal.	
Sample taps provided		
13. pH Control Unit for In Situ Soil Flushing Pilot System:		
Provisions for liquid base addition (NaOH) and mixing		
pH of water	9–10*	
Approximate residence time	4 minutes	
Automatic pH control		

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TABLE 5-4 (Cont.)

PRELIMINARY DESIGN CRITERIA FOR PILOT
WATER TREATMENT SYSTEM

14. Surfactant Addition System for In Situ Soil Flushing Pilot System:

Design flow for recharge water	2 gpm (maximum)
In line surfactant injection system following pH adjustment	
Surfactants added: Rhome and Haas Triton X-100 and Witco Emcol Cocobetaine in an approx. 1:1 ratio by weight.	
In line surfactant addition rate: Design to inject Triton X-100 and Witco Emcol Cocobetaine at a total surfactant addition rate of 1.98 - 14.71 grams/min. at a recharge water design flow of 2 gpm.**	

* Soil washing lab treatability study used a pH of 10. Optimum pH for in situ soil flushing will be confirmed during the pilot study.

** See Section 3.2.4 for rationale.

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The preliminary data requirements prior to implementation of the pilot study are summarized below:

- Pretreatment requirements for the surfactant-containing water. Data on oil/water separation and settleable oil/solids volumes will be collected during preliminary laboratory gravity settling and polymer treatment jar tests conducted prior to the pilot study.

- Feasibility of carbon adsorption treatment of surfactant-containing groundwater. Data will be collected during a laboratory carbon isotherm testing on settled water, prior to the pilot testing. (Data will also be collected on sodium hydroxide requirements for pH adjustment of carbon treated effluent for in situ soil flushing.)

- Environmental fate of surfactants. As discussed in Section 3.1.4, available information related to the environmental fate of the selected surfactants will be gathered.

- The flow rates outlined in Section 5.2 for soil washing and soil flushing pilot studies are preliminary estimates. As more information is available, these flow rates will be refined.

5.4 Water Collection, Treatment and Discharge

This section describes equipment and processes used for the collection and treatment of the water and disposal of the treated water and residues. This section will also outline the sampling and analysis requirements and schedule.

5.4.1 Location of Water Treatment Pilot System

The major components of the water treatment pilot system will be located in the central area of the South Cavalcade site. The approximate location of the water treatment pilot system is shown in Figure 3-1. Electricity and water sources are available in the proximity of this location.

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5.4.2 Major Components of the Treatment System

A schematic of the water collection and treatment system is presented in Figure 5-1. The system will basically contain the components of the full-scale water treatment system, but scaled down for the anticipated pilot system flowrates. If the results obtained from the additional laboratory studies proposed in Section 5.2.2 indicate that other unit processes or strategies would be more appropriate for the surfactant-containing water, process modifications will be included in the detailed design report. The major components of the system will include:

- Soil washing water, groundwater and soil flushing recovery water collection tanks for gravity oil/water separation (existing tanks),
- Oil and solids storage tank,
- Oil/water separation unit with pH adjustment, polymer addition/flocculation and oil/solids separation chambers,
- Multi-media pressure filtration unit,
- Activated carbon adsorption,
- Side stream fluidized bed reactor system,
- Effluent storage tank,
- pH control unit and inline surfactant addition system for in situ soil flushing pilot system, and
- Associated pumps.

Preliminary design criteria for the water treatment pilot system are presented in Table 5-4. These criteria will be refined during the detailed design of the system. A

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design flow rate of 10 gpm was chosen to accommodate the maximum flow with a safety factor of about 1.5.

5.4.3 Raw Water Collection and Gravity Oil/Water Separation

The groundwater trucked to the water treatment system from the groundwater recovery pilot test will be stored in an existing 8,000-gallon fiberglass tank. This tank is currently on site. The in situ soil flushing recovery water will be pumped at an estimated 1-4 gpm and collected in another 8,000-gallon capacity fiberglass tank. At the maximum estimated flow rate of 4 gpm, this tank can store the water for about 1.4 days. The ex situ soil washing wastewater will be stored in an existing 5,000-gallon fiberglass tank. Since the expected maximum flow rate from soil washing is approximately 200 gpd, this tank will have enough capacity for backwash water from the subsequent treatment train.

The above three tanks will also function as a first-stage separation process. These tanks will have provisions to remove solids/oil from the bottom. Gravity-settled dense oils and/or solids in all three tanks will be pumped to a product/solids storage tank of 5,000-gallon capacity. The supernatent water in the three tanks will be pumped to the second phase oil/water separation unit.

Composite raw water samples will be collected from each of the three tanks and analyzed according to the schedule listed in Table 5-5. Grab samples will be collected for volatiles (BTEX) and oil and grease. Samples will be collected with stainless steel bailers, composited and transferred to appropriate sample containers for analysis. The characteristics of the in situ soil flushing recovery water will be used to assess the performance of the soil flushing pilot system.

5.4.4 Oil/Water Separation with pH Adjustment and Polymer Addition

The combined influent (raw) water from the three storage tanks will be pumped to a second stage oil/water separation process designed for a 10 gpm flow. Preliminary design criteria for this unit are presented in Table 5-4. This oil/water separation

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TABLE 5-5
RAW WATER SAMPLING SCHEDULE

Parameter	Recovered Groundwater	In Situ Soil Flushing Water*	Ex Situ Soil Washing Water+
Polynuclear Aromatic Hydrocarbons (PAH)	Bimonthly	1/Month	Bimonthly
Oil & Grease (O&G)	Bimonthly	1/Month	1/Month
Benzene, Toluene, Ethylbenzene, Xylene (BTEX)	Bimonthly	1/Month	Bimonthly
Arsenic (As)**	Bimonthly	1/Month	Bimonthly
Chromium (Cr)**	Bimonthly	1/Month	Bimonthly
Copper (Cu)**	Bimonthly	1/Month	Bimonthly
Lead (Pb)**	Bimonthly	1/Month	Bimonthly
Zinc (Zn)**	Bimonthly	1/Month	Bimonthly
Hardness**	Bimonthly		
Total Organic Carbon (TOC)	Bimonthly	1/Month	1/Month
Chemical Oxygen Demand (COD)		1/Month	
Total Dissolved Solids (TDS)	Bimonthly	1/Month	1/Month
Total Suspended Solids (TSS)		1/Month	1/Month

* During the first 2 months, all parameters will be measured 2/month.

** For in situ soil flushing water, if the initial analysis indicates that metals are not of concern, the frequency of analysis will be bimonthly.

\+ Frequency of analysis of soil washing water at the water treatment unit may decrease depending upon frequency of analysis at soil washing unit.

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unit will provide for pH adjustment and polymer addition, if needed, followed by an oil/solids separation step. pH adjustment and anionic/cationic polymer addition will be used to remove any residual free oils and emulsified oils that pass through the first stage separation. The approximate hydraulic retention time of 5 minutes in the pH adjustment compartment has been found by Keystone to be adequate for similar types of groundwater at other sites. Details of the mixer size, etc. will be provided in the detailed design package. Polymers found effective during the laboratory treatability studies will be further evaluated. The settled oils and sludge will be pumped to an oil/solids storage tank and the effluent water from oil/water separation will be pumped to a multi-media pressure filter.

Since sodium hydroxide is added to raise the pH in the pilot in situ soil flushing system and pH may be adjusted with acid in the oil/water separator, the total dissolved solids (TDS) concentration may increase. TDS will be monitored periodically at several points in the treatment system.

To determine the characteristics of the composite influent stream to the second stage oil/water separator and subsequent treatment train, the composite influent stream will be sampled and analyzed according to the schedule shown in Table 5-6. Composite samples will be collected from a sample tap or an automatic composite sampler and transferred to appropriate sampling containers for analysis. Suitable methods for analysis of surfactants are being investigated. If appropriate methods are identified, surfactants will be analyzed periodically at selected points in the treatment system. This will be discussed in the detailed design report.

The oil/water separation unit will be monitored for operational parameters as listed in Table 5-7. To determine the performance of the second stage oil/water separator, composite samples of the effluent will be collected from a spigot, transferred to sampling containers and analyzed according to the schedule in Table 5-8.

Composite samples will be obtained by collecting samples from the tap at three designated times during the designated sampling day. The samples will be composited as necessary and transferred to sampling containers at the end of the

TABLE 5-6
COMBINED INFLUENT SAMPLING SCHEDULE***

Parameter	Frequency
Polynuclear Aromatic Hydrocarbons (PAH)	1/Month
Oil & Grease (O&G)	2/Month
Benzene, Toluene, Ethylbenzene, Xylene (BTEX)	1/Month
Total Phenols	1/Month
Arsenic (As)*	1/Month
Chromium (Cr)*	1/Month
Copper (Cu)*	1/Month
Lead (Pb)*	1/Month
Zinc (Zn)*	1/Month
Total Organic Carbon (TOC)	2/Month
Ammonia**	1/Month
Nitrate**	1/Month
Nitrite**	1/Month
Phosphate**	1/Month
Chemical Oxygen Demand (COD)	1/Month
Biochemical Oxygen Demand (BOD)	1/Month
Total Dissolved Solids (TDS)	1/Month
Total Suspended Solids (TSS)	1/Month
Volatile Suspended Solids (VSS)	1/Month

* If the initial analysis indicates that metals are not of concern, the frequency of analysis will be bimonthly.

** On site test kit analysis.

***Surfactants will be analyzed periodically if appropriate methods are identified.

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TABLE 5-7

OIL/WATER SEPARATION OPERATIONAL PARAMETERS*

Parameters (influent)	Frequency
pH	Daily
Temperature	Daily
Flow Rate	Daily
Chemical Usage Rate**	Daily
Fluid Density	1/Month
Fluid Viscosity	1/Month
TSS/VSS/FSS***	Weekly

NOTES:

* Field/on site measurements. Effluent sampling schedule is same as influent sampling schedule for filter (Table 5-9).
** In the reactor.
*** In the influent and underflow from solids separation chamber.

TABLE 5-8
PRETREATMENT UNITS SAMPLING SCHEDULE

Parameter	Oil/Water Separator Effluent	Multi-Media Filter Effluent*
Polynuclear Aromatic Hydrocarbons (PAH)	Bimonthly	1/Month
Oil & Grease (O&G)	2/Month	2/Month
Benzene, Toluene, Ethylbenzene, Xylene (BTEX)	Bimonthly	Bimonthly
Arsenic (As)	Bimonthly	1/Month**
Chromium (Cr)	Bimonthly	1/Month**
Copper (Cu)	Bimonthly	1/Month**
Lead (Pb)	Bimonthly	1/Month**
Zinc (Zn)	Bimonthly	1/Month**
Total Organic Carbon (TOC)	1/Month	2/Month
Total Dissolved Solids (TDS)	1/Month	1/Month
Chemical Oxygen Demand (COD)		1/Month
Biochemical Oxygen Demand (BOD)		1/Month
Total Phenols		1/Month

* Will also serve as influent monitoring for the carbon and BiFar units.

** If the initial analysis indicates that metals are not of concern, the frequency of analysis will be bimonthly.

day for appropriate analysis. Grab samples will be collected once per designated day for volatiles (BTEX) and oil grease.

Description of the procedure for collecting composite samples is presented in Section 5.6 of the SAP.

5.4.5 Storage of Oil/Solids and Recycle/Disposal

The oils and solids recovered during the two-phase oil/water separation treatment will be stored in a 5,000-gallon storage tank. Based on the results obtained during the laboratory settling studies (Section 5.3.1) it appears that a 5,000-gallon tank will suffice; however, if oils and solids are produced in larger quantities, additional storage tanks will be used.

The ultimate destination of the recovered oils and solids will be determined after a sufficient quantity has been recovered/generated. The stored oils and solids will be evaluated to determine options for product recovery or disposal. Composite samples of oils and solids will be collected and analyzed for appropriate parameters to develop the required information. Grab samples will be collected for appropriate parameters. The procedure for collecting these composite samples is presented in Section 5.6 of the SAP.

5.4.6 Multi-Media Pressure Filtration

The effluent water from the secondary oil/water separator will be pumped to a multi-media pressure filter to remove suspended solids that may otherwise plug the carbon unit or interfere with the operation of the fluidized bed reactor. Preliminary design criteria for this unit are presented in Table 5-4. The filtration unit will be backwashed to the soil washing water storage tank. Plant effluent from the effluent storage tank will be used for backwashing with tap water as back-up (Figure 5-1). Details of the multi-media pressure filter such as type of media, size of media, media height, etc., will be presented in the detailed design report.

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The effluent stream from the multi-media pressure filter will be sampled from a sample tap and composite samples will be analyzed for the parameters shown in Table 5-8. Grab samples will be obtained for volatiles (BTEX) and oil and grease. Composite samples will be obtained as outlined in Section 5.4.4. This is described in Section 5.6 of the SAP. Results obtained will be used to assess the performance of the pretreatment processes. The influent and effluent streams will also be monitored for other operational parameters presented in Table 5-9.

The main effluent stream from the filter will flow to a carbon treatment system. A side stream will be used as influent to the fluidized bed unit.

5.4.7 Carbon Adsorption System

Granular activated carbon (GAC) adsorption will be used to remove the residual PCOC before discharge (Figure 5-1). Two backwashable granular activated carbon vessels will be operated in series. The carbon usage based on a previous laboratory treatability study (Section 5.3.1) is 2.5 - 2.75 pounds per 1,000 gallons of water treated, but this will be verified and refined in additional carbon isotherm tests (Section 5.3.2). The carbon used in the adsorption process will be regenerated offsite. The total empty bed contact time (EBCT) for the two vessels is expected to be in the 60-110 minute range and will be refined during the additional carbon isotherm tests. The carbon vessels will be backwashed with plant effluent or back-up tap water and the backwash water will be discharged to the soil washing water storage tank at the head of the plant. The effluent from the carbon system will be discharged to an effluent storage tank.

Effluent from both the first and second carbon columns will be monitored for operational parameters as shown in Table 5-10. Effluent from the first carbon column will be sampled from a sample tap and samples will be analyzed according to the schedule presented in Table 5-11. Grab or composite samples will be collected from the effluent from the first carbon unit, with the sampling methodology contingent upon the method specified for the treatment system final effluent. The analysis of the plant effluent as shown in Table 5-12 will serve to monitor the effluent quality from the second carbon column. The fluidized bed

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TABLE 5-9

MULTI-MEDIA FILTRATION MONITORING PARAMETERS

Parameters	Frequency Influent*	Effluent
pH	Daily	Daily
Temperature	Daily	Daily
Flow Rate	Daily	Daily
Pressure Drop	Daily	Daily
Fluid Density	1/Month	1/Month
Fluid Viscosity	1/Month	1/Month
TSS/VSS/FSS	Weekly	Weekly

* Will also serve as effluent monitoring for second step oil/water separation.

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TABLE 5-10

ACTIVATED CARBON COLUMNS

MONITORING PARAMETERS*

Parameters	Frequency Column 1 Effluent	Column 2 Effluent
pH	Daily	Daily
Temperature	Daily	Daily
Pressure Drop	Daily	Daily
Flow Rate	1/Week	1/Week
TSS/VSS/FSS	2/Week	2/Week
Phenolics (test kit)		

*Field/on site measurements

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TABLE 5-11

EFFLUENT SAMPLING SCHEDULE FOR
CARBON AND FLUIDIZED BED TREATMENT UNITS

Parameter	Carbon Unit #1 Effluent	Carbon Unit #2 Effluent*	Fluidized Bed Effluent
Polynuclear Aromatic Hydrocarbons (PAH)	Bimonthly		1/Month
Oil & Grease (O&G)			2/Month
Benzene, Toluene, Ethylbenzene, Xylene (BTEX)			Bimonthly
Arsenic (As)**			1/Month
Chromium (Cr)**			1/Month
Copper (Cu)**			1/Month
Lead (Pb)**			1/Month
Zinc (Zn)**			1/Month
Total Organic Carbon (TOC)	1/Month		1/Month
Chemical Oxygen Demand (COD)			1/Month
Biochemical Oxygen Demand (BOD)			1/Month
Total Dissolved Solids (TDS)	1/Month		1/Month
Total Phenols			1/Month

* Analysis of plant effluent (Table 5-13) will also serve to monitor the Carbon Unit #2. Fluidized bed effluent should have little impact if flow rates are as expected.

** If the initial analysis indicates that metals are not of concern, the frequency of analysis will be bimonthly.

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TABLE 5-12
PLANT EFFLUENT SAMPLING SCHEDULE

Parameter	Frequency
Flow*	1/Day
Polynuclear Aromatic Hydrocarbons (PAH)	1/Month
Oil & Grease (O&G)	2/Month
Benzene, Toluene, Ethylbenzene, Xylene (BTEX)	1/Month
Total Phenols (4-AAP)	1/Month
Arsenic (As)**	1/Month
Chromium (Cr)**	1/Month
Copper (Cu)**	1/Month
Lead (Pb)**	1/Month
Zinc (Zn)**	1/Month
Total Organic Carbon (TOC)	2/Month
Ammonia***	2/Month
Nitrate***	2/Month
Nitrite***	2/Month
Phosphate***	2/Month
Chemical Oxygen Demand (COD)	1/Month
Biochemical Oxygen Demand (BOD)	1/Month
Total Suspended Solids (TSS)	1/Month
Volatile Suspended Solids (VSS)	1/Month
Total Dissolved Solids (TDS)	1/Month
pH*	2/Week

* Field measurement.

** If the initial analysis indicates that metals are not of concern, the frequency of analysis will be bimonthly.

***On site test kit analysis.

effluent should have little impact if flow rates are as expected. The results will be used to determine the performance of the carbon treatment system.

5.4.8 Fluidized Bed Reactor Operation

During the water treatment pilot study, a side stream from the multi-media filter effluent will be diverted to a pilot-scale upflow fluidized bed reactor system (Figure 5-1). The feed rate used will be 0.2 gpm (maximum).

The preliminary design criteria for the pilot fluidized bed unit are presented in Table 5-4. The side stream from the filter will flow into an influent holding tank where the pH of the influent feed will be adjusted and nutrients will be added, as necessary. The influent will then be pumped into the fluidized bed reactor. The effluent from the reactor will flow into a recycle tank, from which water will be recycled by pumping to the inlet of the fluidized bed reactor. The overflow from the recycle tank will be collected in an effluent tank and pumped to the line carrying the effluent from the second carbon vessel to the effluent storage tank.

At the startup of the system, the activated carbon in the fluidized bed will be saturated with organic constituents by pumping the influent feed through the system. The system will be seeded with biomass from a wood treating plant's biological wastewater treatment system. The feed rate will be adjusted to 0.2 gpm and the recycle rate will be adjusted to maintain 25-30% carbon bed expansion within the column. The system will be maintained under these conditions for a 2-4 week acclimation period.

The effect of loading rate on the fluidized bed performance will be evaluated by varying the influent feed rate to the column under constant recycle flow rate. The feed rates to be used will be selected depending on their impact upon the effluent quality. Each feed rate will be studied for a period of about four weeks. The quality of the fluidized bed effluent will be determined by collecting composite samples of the effluent from a spigot or from the fluidized bed effluent tank and analyzing according to the schedule presented in Table 5-11. Grab samples will be collected once per designated day for volatiles (BTEX) and oil and grease. Composite samples will be obtained from the sample tap as outlined in Section 5.4.4. Other process/operating parameters will also be determined per the schedule presented in Table 5-13.

5.4.9 Storage of Pilot Plant Effluent and Discharge

The effluent from the carbon adsorption units as well as the fluidized bed unit will be collected in a 15,000-gallon effluent storage tank (Figure 5-1). This tank will be designed to store about a day's flow of effluent at the design plant flow rate of 10 gpm. The effluent in this tank will serve as a source of water for backwashing the pressure filter and carbon adsorption units. Part of the effluent will be pumped, as necessary, to the soil washing pilot system (1 - 200 gpd) for use as wash and rinse water. A portion of the effluent will be pumped on a continuous basis (with temporary down periods for maintenance) for use as recharge water to the in situ soil flushing pilot system. The remaining effluent will be discharged off site by pumping to the drainage ditch near the eastern boundary of the site for eventual discharge into Little Whiteoak Bayou per an NPDES permit. The NPDES permit will be obtained before the start of the pilot studies. If the plant effluent does not comply with the NPDES permit limitations, the effluent will be recycled for treatment.

The pilot plant effluent sampling and analysis schedule is shown in Table 5-12. Grab or composite samples, as required, will be collected from the effluent storage tank with stainless steel bailers or from sample taps. Grab sampling will be used for volatiles (BTEX) and oil and grease. Composite samples, if required, will be obtained as outlined in Section 5.4.4. The results will also serve for characterizing the recharge water for the in situ soil flushing unit and the wash water to be used for soil washing.

5.4.10 Above Grade Components of the In Situ Soil Flushing Pilot System

The above grade components of the in situ soil flushing pilot system include the following (Figure 5-1):

TABLE 5-13

FLUIDIZED BED TREATMENT UNIT

MONITORING PARAMETERS*

Monitoring Parameters	Frequency Influent	Effluent
pH	Daily	Daily
Temperature	Daily	Daily
Flow Rate**	Daily	Daily
Dissolved Oxygen	Daily	Daily
Total Dissolved Solids	2/Week	2/Week
Chemical Usage Rate	Daily	Daily
TSS/VSS/FSS	2/Week	2/Week
Ammonia	2/Week	2/Week
Nitrite	2/Week	2/Week
Nitrate	2/Week	2/Week
Phosphate	2/Week	2/Week
Microscopic Observation	2/Week	2/Week
Bed Height**	2/Month	2/Month

* Field/on site measurements

** Recycle Flow Rate will be monitored 2/Week

*** Both Static and Fluidized

- soil flushing recovery water storage tank,
- pH control unit,
- surfactant injection system, and
- associated pumps.

The recovered groundwater from the in situ soil flushing trench drain system in the northern area of the site will be pumped at 1-4 gpm to the 8,000-gallon recovery water storage tank located at the head of the water treatment pilot system. This water will be sampled and analyzed for the parameters shown in Table 5-5, as described in Section 5.4.3. The results will help assess the performance of the in situ soil flushing pilot system.

The treated effluent from the water treatment pilot system will serve as the source of recharge water for soil flushing and will be analyzed per Table 5-12. A portion of the treatment plant effluent will flow to a pH control unit which will have provisions for sodium hydroxide addition and mixing. The pH of the water will be adjusted to be in the range of 9-10. Liquid sodium hydroxide will be added as required with the help of an automatic pH control unit. An estimate of sodium hydroxide required to adjust the pH of the treatment plant effluent in the range of 9-10 will be obtained during additional treatability studies. The optimum pH to be used for in situ soil flushing will be evaluated and refined during the pilot studies. Following pH adjustment, the water will be mixed with the selected surfactants by means of an inline surfactant injection system which will be placed ahead of a pump (Figure 5-1) to minimize foaming. The surfactants added will be Rhom and Haas Triton X-100 and Witco Emcol Cocobetaine as discussed in Section 3.2.3. The recharge water containing surfactants will be pumped to the soil flushing distribution system in the northern area of the site. The recovery water line and the recharge water system will be monitored for operational parameters per the schedule presented in Table 5-14.

In order to ensure that the carbon treatment system is not overcome by the surfactants in the pilot in situ soil flushing and soil washing wastewater, an additional laboratory carbon isotherm test will be performed as explained in Section

TABLE 5-14

RECOVERY LINE AND RECHARGE SYSTEM MONITORING PARAMETERS*

	Recovery Line	Recharge System
Flow Rate	Daily	Daily
pH	Daily	Daily
Temperature	Daily	Daily
Dissolved Oxygen	Daily	Daily
Hardness	2/Month	
Chemical Usage Rate**		Daily

* Field/on site measurements.
** In the pH control unit and surfactant addition system.

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5.3.2 to determine (a) the feasibility of using carbon adsorption for surfactant-containing water, and (b) the carbon usage rate. The results of this study will be used to modify the proposed pilot system, if necessary. Routine monitoring of carbon Unit #1 effluent (see Tables 5-10 and 5-11) will also ensure that breakthrough is not occurring and the system is operating satisfactorily.

5.5 Above Grade System Design

Preliminary data requirements have been identified in Section 3.1 for planning of the below grade soil flushing pilot system and in Section 4.0 for the ex situ soil washing system. These will influence the design of the above grade systems. Other data needs for design of the above grade system were identified in Section 5.3.2.

When these data requirements are met to the extent possible, a detailed design report of the above grade systems relating to the in situ soil flushing and water treatment pilot systems will be prepared. This report will contain detailed design analyses, design drawings and construction specifications for the above-grade pilot systems. The final design will include all tasks necessary to produce a construction bid package for the above ground components of the water treatment and in situ soil flushing system.

5.6 Report of Findings

At the completion of the pilot test a report will be prepared describing the results of the pilot test. This report will include a description of the technologies, the methods used to evaluate the technologies, and the results of the studies. Recommendations will be included for the design and operation of the full-scale system. An example of a typical outline for the Report of Findings is presented in Table 5-15.

TABLE 5-15

OUTLINE FOR REPORT OF FINDINGS

1.0 Introduction

- 1.1 Objectives
- 1.2 Background
  - 1.2.1 History
  - 1.2.2 Extent of Potential Impact
  - 1.2.3 Technology Description
- 1.3 Report Organization

2.0 Summary of Sampling on Field Testing

3.0 Study Procedure

4.0 Study Results

5.0 Conclusions and Recommendations

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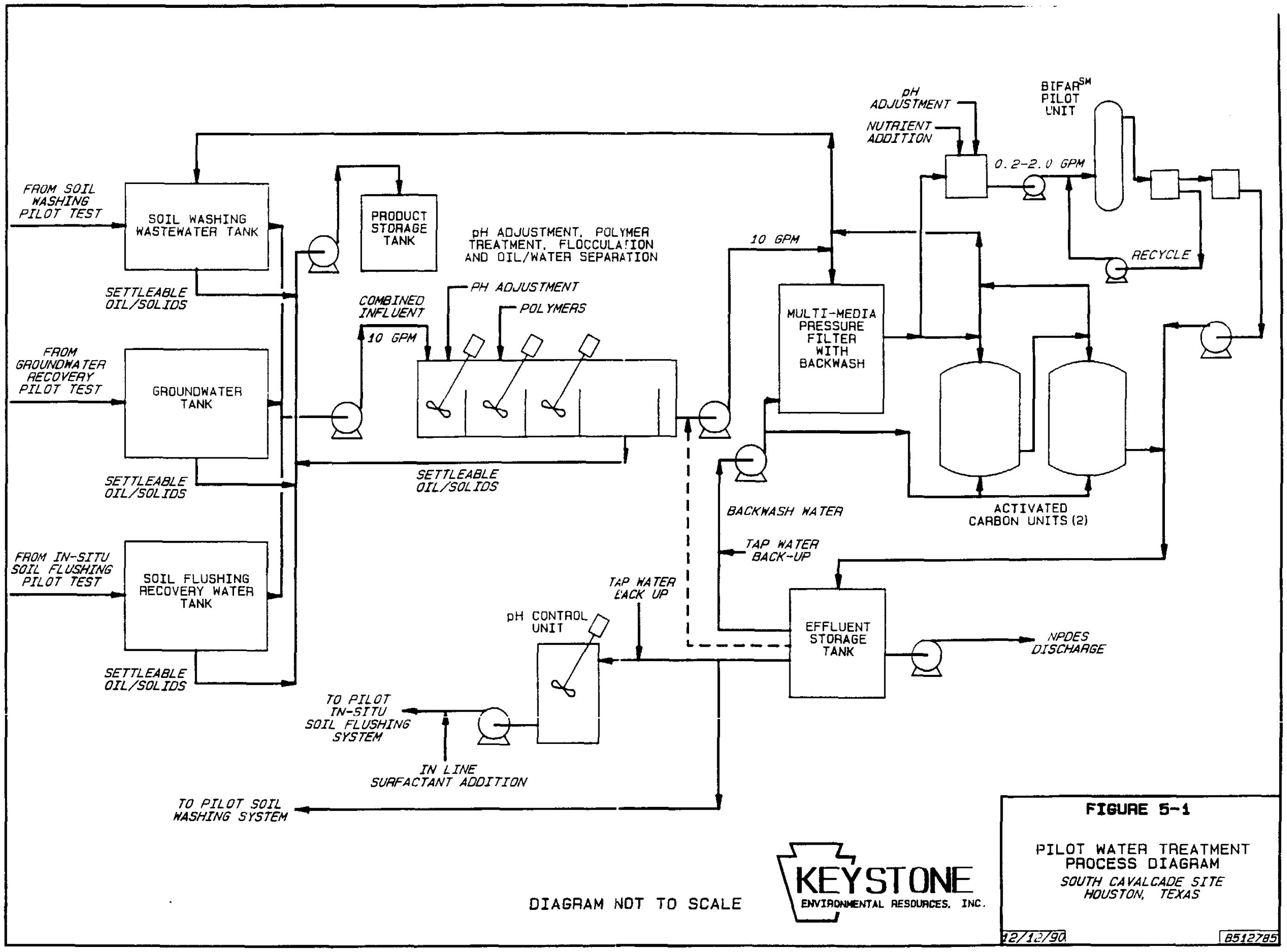

FIGURE 5-1

PILOT WATER TREATMENT PROCESS DIAGRAM

SOUTH CAVALCADE SITE HOUSTON, TEXAS

6.0 TEST METHODS

The following references the various analytical and physical testing methods corresponding to the specified data requirements presented in this Work Plan. A more detailed description is included in the SAP and QA/QC requirements are presented in the QAPP.

6.1 Operational Monitoring

During the pilot treatability testing, operational monitoring of several parameters will be conducted for various processes. These parameters will be measured using test kit methods in the field. The operational parameters monitored in the pilot in situ soil flushing system and water treatment system are shown in Table 5-7, 5-9, 5-10, 5-13 and 5-14. The appropriate test kits and field methods are presented in Table 6-1 and discussed in the SAP.

6.2 Environmental Fate Monitoring

The various analytical methods to be used in the analysis of water and soil samples are presented in Tables 6-2 and 6-3, respectively. Detection limits are also shown but these may vary depending on sample matrix and interferences. Analytical QA/QC will be provided by field blanks, trip blanks and laboratory duplicates and spikes, if necessary.

6.3 Physical Soils Tests

Physical testing will be performed by qualified personnel. The test methods will adhere to the appropriate American Society for Testing and Materials (ASTM) or other accepted procedure. Table 6-4 identifies the test parameters and test methods for the physical soil testing activities.

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TABLE 6-1
TEST KIT AND FIELD ANALYSIS FOR WATER

Ammonia	Model K-1510	Chemetrics
Nitrate/Nitrite	Model N1-12	HACH
Ortho-phosphate	Model PO-19A	HACH
Phenolics	Model K-8012	Chemetrics
pH	Meter (Orion or Fisher)	
Temperature	Thermometer (Mercury)	
Dissolved Oxygen	Model 57	YSI
Fluid Density	ASTM D 1429	
Fluid Viscosity	ASTM D 445	
Microscopic Observation	Light Microscope	
Solids (TDS/TSS/VSS/FSS)	EPA 160.1/160.2/160.4	

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TABLE 6-2

ANALYTICAL TESTING METHODS FOR WATER

Parameter	Analytical Method	Practical Quantitation Limit
pH	EPA 150.1	---
Oil and Grease	EPA 413.1	5 mg/l
Total Phenols (4-AAP)	EPA 420.2	0.005 mg/l
Total Organic Carbon	EPA 415.1	1 mg/l
Biochemical Oxygen Demand	EPA 405.1	1 mg/l
Chemical Oxygen Demand	EPA 410.1	10 mg/l
Total Dissolved Solids	EPA 160.1	1 mg/l
Total Suspended Solids	EPA 160.2	1 mg/l
Volatile Suspended Solids	EPA 160.4	1 mg/l
Polynuclear Aromatic Hydrocarbons		
Acenaphthene	EPA 8270	10 ug/l
Acenaphthylene	EPA 8270	10 ug/l
Anthracene	EPA 8270	10 ug/l
Benzo(a)anthracene	EPA 8270	10 ug/l
Benzo(a)pyrene	EPA 8270	10 ug/l
Benzo(b)fluoranthene	EPA 8270	10 ug/l
Benzo(g,h,i)perylene	EPA 8270	10 ug/l
Benzo(k)fluoranthene	EPA 8270	10 ug/l
Chrysene	EPA 8270	10 ug/l
Dibenz(a,h)anthracene	EPA 8270	10 ug/l
Fluoranthene	EPA 8270	10 ug/l
Fluorene	EPA 8270	10 ug/l
Indeno(1,2,3-cd)pyrene	EPA 8270	10 ug/l
Naphthalene	EPA 8270	10 ug/l
Phenanthrene	EPA 8270	10 ug/l
Pyrene	EPA 8270	10 ug/l
Metals		
Arsenic	EPA 7060	10 ug/l
Chromium	EPA 6010	10 ug/l
Copper	EPA 6010	25 ug/l
Lead	EPA 6010	3 ug/l
Zinc	EPA 6010	20 ug/l
Volatile Organics		
Benzene	EPA 8020	0.2 ug/l
Toluene	EPA 8020	0.2 ug/l
Ethylbenzene	EPA 8020	0.2 ug/l
Xylene	EPA 8020	0.3 ug/l

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TABLE 6-3

ANALYTICAL TESTING METHODS FOR SOILS

Parameter	Analytical Method	Practical Quantitation Limit
pH	EPA 9045	--
TCLP Extraction	EPA 1311	--
Microbial Count		
Polynuclear Aromatic Hydrocarbons		
Acenaphthene	EPA 8270	660 ug/kg
Acenaphthylene	EPA 8270	660 ug/kg
Anthracene	EPA 8270	660 ug/kg
Benzo(a)anthracene	EPA 8270	660 ug/kg
Benzo(a)pyrene	EPA 8270	660 ug/kg
Benzo(b)fluoranthene	EPA 8270	660 ug/kg
Chrysene	EPA 8270	660 ug/kg
Dibenz(a,h,)anthracene	EPA 8270	660 ug/kg
Fluoranthene	EPA 8270	660 ug/kg
Fluorene	EPA 8270	660 ug/kg
Indeno(1,2,3-cd)pyrene	EPA 8270	660 ug/kg
Naphthalene	EPA 8270	660 ug/kg
Phenanthrene	EPA 8270	660 ug/kg
Pyrene	EPA 8270	660 ug/kg
TCLP Extract		
PAH	EPA 8270	Same as Table 6-1
Arsenic	EPA 7060	10 ug/l
Chromium	EPA 6010	10 ug/l
Copper	EPA 6010	25 ug/l
Lead	EPA 6010	5 ug/l
Zinc	EPA 6010	20 ug/l

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TABLE 6-4

PHYSICAL TESTING METHODS FOR SOILS

Parameter	Test Method
Atterberg Limits	ASTM (1) D 4318
Classification	ASTM D 2487
Description	ASTM D 2488
Dispersive Nature	ASTM D 4221
Grain Size	ASTM D 421
In-Place Unit Weight	as described in ASTM D 2166
Natural Moisture Content	ASTM D 2216
Permeability	SW 925 (2)
Sieve Analysis	ASTM D 422
Specific Gravity	ASTM D 854
Standard Penetration Test	ASTM D 1586
Standard Protector Method	ASTM D 698
Relatively Density Test	ASTM D 4253 and ASTM D 4254

Notes:

(1) ASTM - American Society for Testing and Materials

(2) EPA Manual "Soil Properties, Classification, and Hydraulic Conductivity Testing" Washington D.C., (1984).

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7.0 APPROACH TO IN SITU BIOREMEDIATION PILOT TESTING

The in situ soil flushing pilot studies will be run for a period of about eight months. If the results obtained during this pilot study shows that in situ soil flushing with surfactants will not effectively flush the PCOCs in a reasonable time period, a pilot program for in situ bioremediation will be subsequently implemented.

The in situ bioremediation pilot test will be conducted using the same recharge and trench drain recovery system described in Section 3.0. In this case, the residual PCOCs will be evaluated for further microbial degradation. Alternately, a new recharge and groundwater extraction system will be installed in an area containing PCOCs east of the previous soil flushing area in the northern portion of the South Cavalcade site. The decision as to whether a new system will be installed will be made based on the results and operational experience obtained from the in situ soil flushing pilot study, and the pilot water treatment study. The recharge water will be mixed with nutrients such as nitrogen and phosphorus, and an oxygen source such as hydrogen peroxide to increase the dissolved oxygen concentration of the recharged water. Enhanced aerobic biodegradation of the soil constituents of concern will be evaluated.

The above grade equipment used for the in situ biodegradation pilot program will be essentially the same as that presented in Figure 5-1, with modifications as necessary. Extracted groundwater will be stored in the soil flushing recovery water tank. This water will be treated by oil/water separation, filtration and by an upflow, aerobic fluidized bed reactor or carbon adsorption as shown in Figure 5-1. The effluent will be stored and a portion will be conditioned for groundwater recharge using pH control, nutrient addition and hydrogen peroxide addition as shown in Figure 7-1. The pH adjustment unit used for the in situ soil flushing system will be modified with provisions for acid/base addition and nutrient (nitrogen and phosphorus sources) addition. Hydrogen peroxide will be injected in line to serve as the oxygen source. The nutrient- and oxygen-enriched recharge water will be pumped to the in situ bioremediation system for subsurface injection. Natural soil bacteria will be used for in situ bioremediation with seeding, if found necessary.

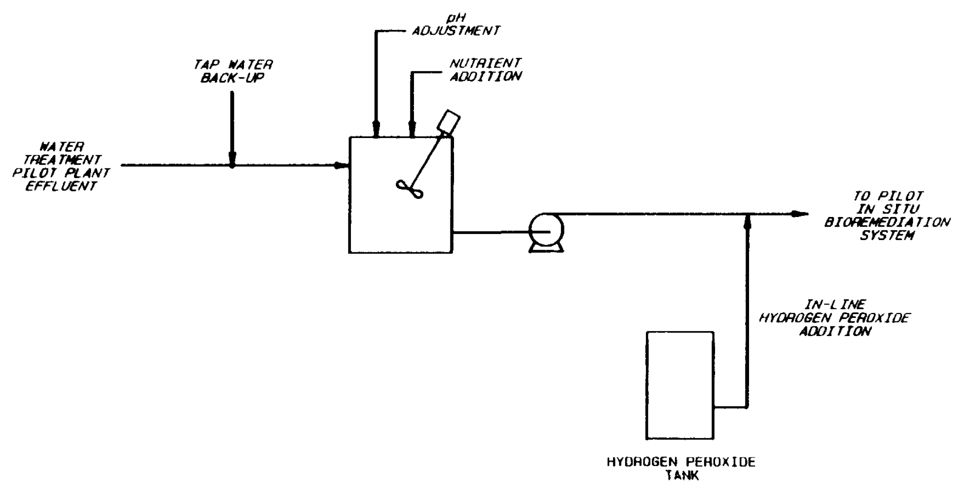

DIAGRAM NOT TO SCALE

KEYSTONE
ENVIRONMENTAL RESOURCES, INC.

FIGURE 7-1

ABOVE GRADE COMPONENTS
PILOT IN SITU BIOREMEDIATION
SYSTEM

BEAZER EAST, INC.
SOUTH CAVALCADE SITE
HOUSTON, TEXAS

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Any excess treated effluent will be discharged off site under the NPDES permit or to a POTW under a pretreatment permit. The in situ bioremediation pilot system will be operated for a period of about six months or longer if it proves to be effective in reducing the concentrations of PCOCs. A separate work plan for the in situ bioremediation pilot testing will be prepared prior to implementing this phase, if required.

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8.0 SCHEDULE

All work performed by Beazer shall be performed in accordance with the schedule specified in Section 9 and Section 10 of the Statement of Work.

1. Within 30 days of EPA's approval of the Remedial Design Work Plan (RDWP), including the approval of the Treatability Study Work Plan, Beazer shall start the field work, for the Site Investigation and the Groundwater Extraction Pilot Study.

2. Within 90 days of initiating field work for the Site Investigation and Groundwater Extraction Pilot Test, Beazer shall submit the Draft Soil Investigation Report and Draft Groundwater Extraction Pilot Study Report.

3. Within 60 days of submittal of the Draft Soil Investigation Report (as described in the SAP), Beazer shall submit to EPA the Draft Pilot Study Design (PSD) which includes the design for the Water Treatment, Soil Washing, and Soil Flushing Pilot Studies.

4. Within 30 days of receipt of the PSD, EPA shall notify Beazer of their comments.

5. Within 30 days, Beazer shall submit to EPA a revised PSD in response to EPA's comments.

6. Within 15 days, EPA shall either approve or disapprove the PSD with comments.

7. If the PSD is disapproved, Beazer shall respond to each comment and resubmit the PSD within 30 days of EPA's approval.

8. Within 15 days of receipt of the resubmitted PSD, EPA shall approve or disapprove the PSD.

9. Within 20 days of the issuance of the permit to discharge water or approval of the PSD whichever is later, Beazer shall start the field work for the remaining pilot studies.

10. Within 180 days of the start of field work for the pilot studies (except the Groundwater Extraction Pilot Study), Beazer shall complete all field work for the Water Treatment and Soil Washing Pilot Studies.

11. Within 240 days of the start of field work for the pilot studies (except the Groundwater Extraction Pilot Study) Beazer shall complete all field work for the Soil Flushing Pilot Study.

12. During the pilot study field work, meetings shall be held monthly (or less frequently if mutually agreed upon in writing) between the EPA and Beazer to discuss the status of the field work.

13. Beazer shall notify EPA within 10 days of the completion of the field work for each pilot study.

14. Beazer shall submit to EPA within 60 days of the completion of all field activities for each pilot study the following:

    - Draft Soil Washing Pilot Study Report
    - Draft Trench Drain/Soil Flushing Pilot Study Report
    - Draft Water Treatment Pilot Study Report

15. Within 45 days after receipt of each draft report, EPA will provide comments to Beazer.

16. Within 45 days of receipt of EPA's comments on each draft report, Beazer shall submit to EPA a final report which responds to EPA's comments.

17. Within 30 days of receipt of each final report, EPA will notify Beazer of its approval or disapproval with EPA comments.

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18. If a final report is disapproved, Beazer shall respond to each comment and resubmit the report within 15 days of receipt of EPA's disapproval. 009481

19. Within 15 days of receipt of the resubmitted final report, EPA will approve or disapprove the report.

20. If, based on the results of any of the pilot studies, the EPA determines the objectives of the Remedial Action cannot be met, Beazer shall within 30 days of such determination by EPA submit to EPA a brief summary of alternatives. If after review, EPA determines further action or investigation is required, Beazer shall initiate such additional action or investigation in accordance with a mutually agreed upon schedule.

A more detailed schedule is presented in Figure 8-1.

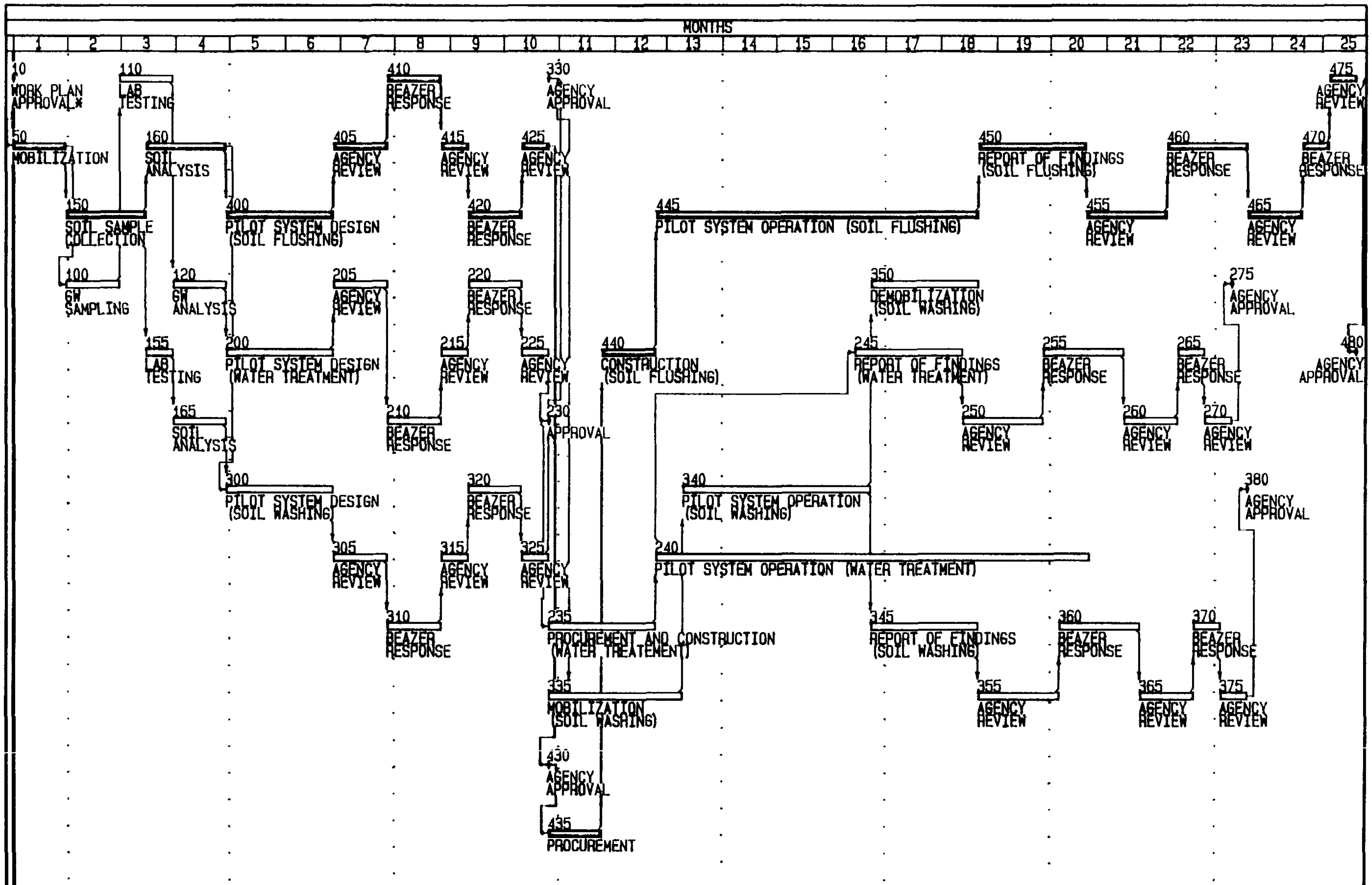

FIGURE 8-1

Activity Bar/Early Dates
Critical Activity
Progress Bar

Primavera Systems, Inc. 1984-1991

PILOT SCALE STUDIES
BEAZER EAST, INC.
SOUTH CAVALCADE

Sheet 1 of 1

Plot Date: 23SEP91

PREPARED BY: D. McCAUSLAND 157350-01

Date	Revision	Checked	Approved

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HEALTH AND SAFETY AND CONTINGENCY PLAN

REMEDIAL DESIGN WORK PLAN
SOUTH CAVALCADE SITE
HOUSTON, TEXAS

Prepared for:

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MARCH 1992

APPROVED BY: ______________________ DATE: __________
Health and Safety Manager

APPROVED BY: ______________________ DATE: __________
Project Manager
Beazer East, Inc.

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1.0 INTRODUCTION

This Worker Health and Safety Plan (WHSP) has been developed to provide the practical health and safety framework for the proposed soil and groundwater remediation at the South Cavalcade Site in Houston, Texas. The Health and Safety Plan incorporates, as a minimum, the contractor's corporate health and safety program and is intended to provide minimum procedural and equipment requirements for protection of workers on site. Special requirements, not included in this plan, will be developed as Health and Safety Plan Revision Guides or Health and Safety Plan Revision Requests/Notices. Health and Safety Plan Revision Guides and Requests shall have concurrence of the Health and Safety Manager (HSM), as appropriate, prior to initiation of the work tasks.

Health and Safety Plan Revision Notices originate in the field by the Site Health and Safety Officer (SHSO) and require no home office concurrence. Health and Safety Plan Revision Requests originate in the field by the SHSO and require home office approval by the HSM. Health and Safety Plan Revision Guides originate in the home office will become attachments to the Health and Safety Plan.

Strict adherence to this plan by all persons on site is required. All operations on the South Cavalcade site shall be conducted in compliance with federal, state, and local requirements using recognized, prudent practices or procedures determined necessary by the HSM.

Corporate instruments and project health and safety procedures have been incorporated to supplement this health and safety plan. These are essential elements of the overall health and safety program that provide detailed guidance for performing health- and safety-related activities.

The HSM and the SHSO will implement each section of this health and safety plan as it applies to the operations undertaken.

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2.0 STAFF ORGANIZATION, RESPONSIBILITIES, AUTHORIZATION AND QUALIFICATIONS

The Contractor's Health and Safety Services is responsible for the evaluation and coordination of project health and safety. This includes evaluating all data and field performance functions that may impact health and safety, appointing SHSOs as needed, implementing and modifying this health and safety plan. Quality Assurance (QA) may audit field operations to determine compliance with Health and Safety requirements. Appendix C gives the names and phone numbers for both site and home office personnel responsible for health and safety. Notification to Beazer by the Contractor of individuals selected for various positions will take place after the RD Contractor is selected but prior to start of field work. Beazer will then notify EPA of these individuals. The SHSO shall report to the HSM. All appointments of SHSOs must be approved by the HSM or his designee. Health and safety authority lies in a chain of command headed by the HSM, maintained in the field by the site health and safety officer (SHSO). The health and safety responsibilities, authorities, and qualifications of these individuals are discussed in this section. An organization chart is shown in Figure 2-1.

2.1 PROJECT MANAGER (PM)

The Project Manager has overall responsibility for the project and he or she must ensure that adequate staff and resources are available to conduct an effective health and safety program and emergency response program. The PM is also responsible for enforcing health and safety requirements at the site.

2.2 HEALTH AND SAFETY MANAGER (HSM)

The Health and Safety Manager is responsible for ensuring the development and implementation of an effective health and safety program which includes quality procedures for handling emergency conditions. He is responsible for ensuring that the project provides an adequate budget for equipment and qualified personnel to implement the program. He will audit and enforce all health and safety requirements and be familiar with federal, state, and local regulations as well as the contractor's policies and procedures. The responsibilities of the HSM include the following:

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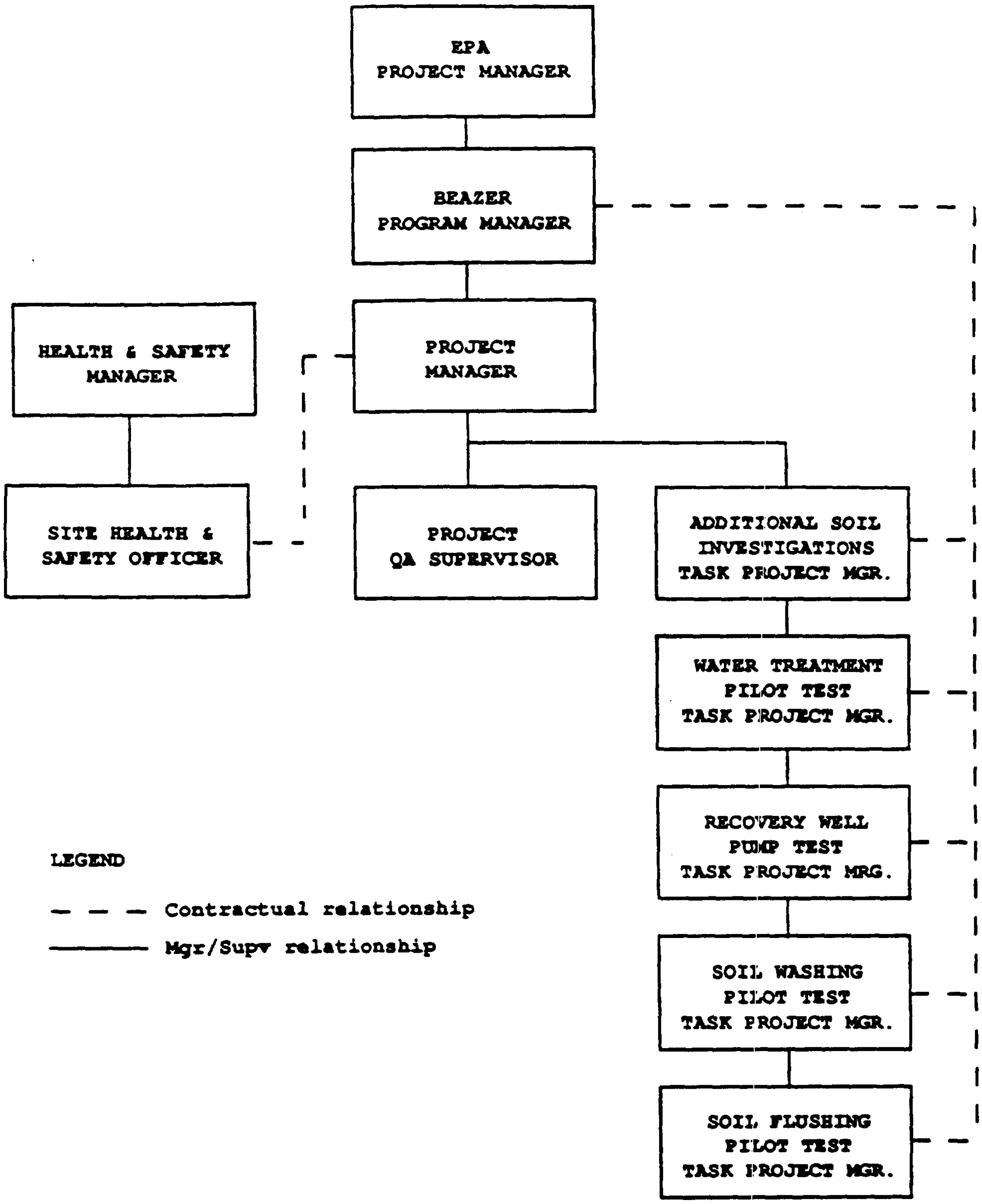
Figure 2-1



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- Act as the primary contact for health and safety matters between the client and the contractor.
- Perform field inspections of health and safety related operations to check conformance with this plan.
- Investigate reports of incidents or accidents and officially report findings.
- Assist in hazardous waste site training as necessary. Supervise the SHSO.
- Develop any new safety protocols and procedures necessary for new field operations.
- Resolve major outstanding health and safety issues which arise during field operations.
- Provide internal review and approval of health and safety plans.
- Audit key aspects of health and safety program.

The authority of the HSM or his representative shall include the following:

- Approve the health and safety qualifications of employees to fill designated roles on-site.
- Approve project health and safety plans.
- Establish employee training and medical surveillance protocols.
- Stop work at site if health and safety conditions warrant.
- Temporary suspension of an individual from field activities for infractions of this plan, pending an evaluation by the SHSO and HSM.

2.3 SITE HEALTH AND SAFETY OFFICER (SHSO)

The SHSO is responsible for the administration and implementation of the health and safety program at the site. He will coordinate site health and safety activities with the Project Manager (PM) and report to the HSM. Responsibilities of the SHSO include:

- To remain present on-site during all field activities to enforce compliance with this plan.

- Conduct daily on-site safety briefings for all site personnel.
- Verify that communication systems are in place.
- Manage health and safety equipment (respirators, instruments, boots, gloves, suits) used at the site.
- Establish work/rest regimen in conjunction with site manager.
- Conduct emergency response provisions in conjunction with local authorities (hospital, fire, police).
- Monitor and inspect health and safety conditions during the site work.
- Fill out Accident/Injury Reports when necessary.
- Maintain a site safety log to record air monitoring results, weather conditions, employees on site, safety problems, and similar information.
- Oversee the setup, inspection, and execution of decontamination.
- Transmit to the project manager originals of all Health and Safety records generated at the site.
- Provide the fire department and hospital with information regarding the planned operations.
- Report health and safety violations to the HSM.
- Stop work if conditions are determined unsafe.
- Remove (or have removed) any individuals not complying with this plan.

2.4 EMERGENCY RESPONSE TEAM

The Emergency Coordinator, SHSO, and other designated and trained by the Emergency Coordinator or SHSO, shall respond at the site in the event of an emergency. The SHSO shall initiate a detailed fire prevention and protection training program.

Supervisors are responsible for maintaining a constant awareness of the fire potential in their area of responsibility and scheduling specific training for aspects of fire prevention and protection unique to that area.

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3.0 SITE BACKGROUND

A brief historical background of the South Cavalcade site is given in Section 1 of the "Detailed Statement of Work for the South Cavalcade Site," Bechtel Environmental, Inc., May 1990. General location of the site is shown in Figure 3.1. A detailed site map showing routes to the hospital is shown in Appendix D.

A remedial investigation (RI) was conducted by Keystone Environmental Resources (Keystone) for Koppers Company, Inc. (Koppers) in mid-1988. During the RI, four general areas of the site were found to have elevated levels of residual organics and PAH concentrations above the defined remedial goals. Residual creosote tars and oil stains were found in the top 6 ft of surface (0 - 0.5 ft) and surficial (0.5 - 6.0 ft) soils.

Current and past operations at this site have impacted soils and the upper aquifer and intermediate discontinuous zone under a portion of the site. Groundwater sampling during the RI indicated that the shallow aquifer was impacted (approximately 6 to 20 feet below grade). The main constituents of concern are polynuclear aromatic hydrocarbons (PAHs) associated with creosote wood preserving operations. Elevated levels of these constituents were also found in the intermediate discontinuous sand lenses (approximately 50 feet below grade). Two areas of affected groundwater exist at the site as defined in the RI; one in the southern portion and one in the northern portion of the site.

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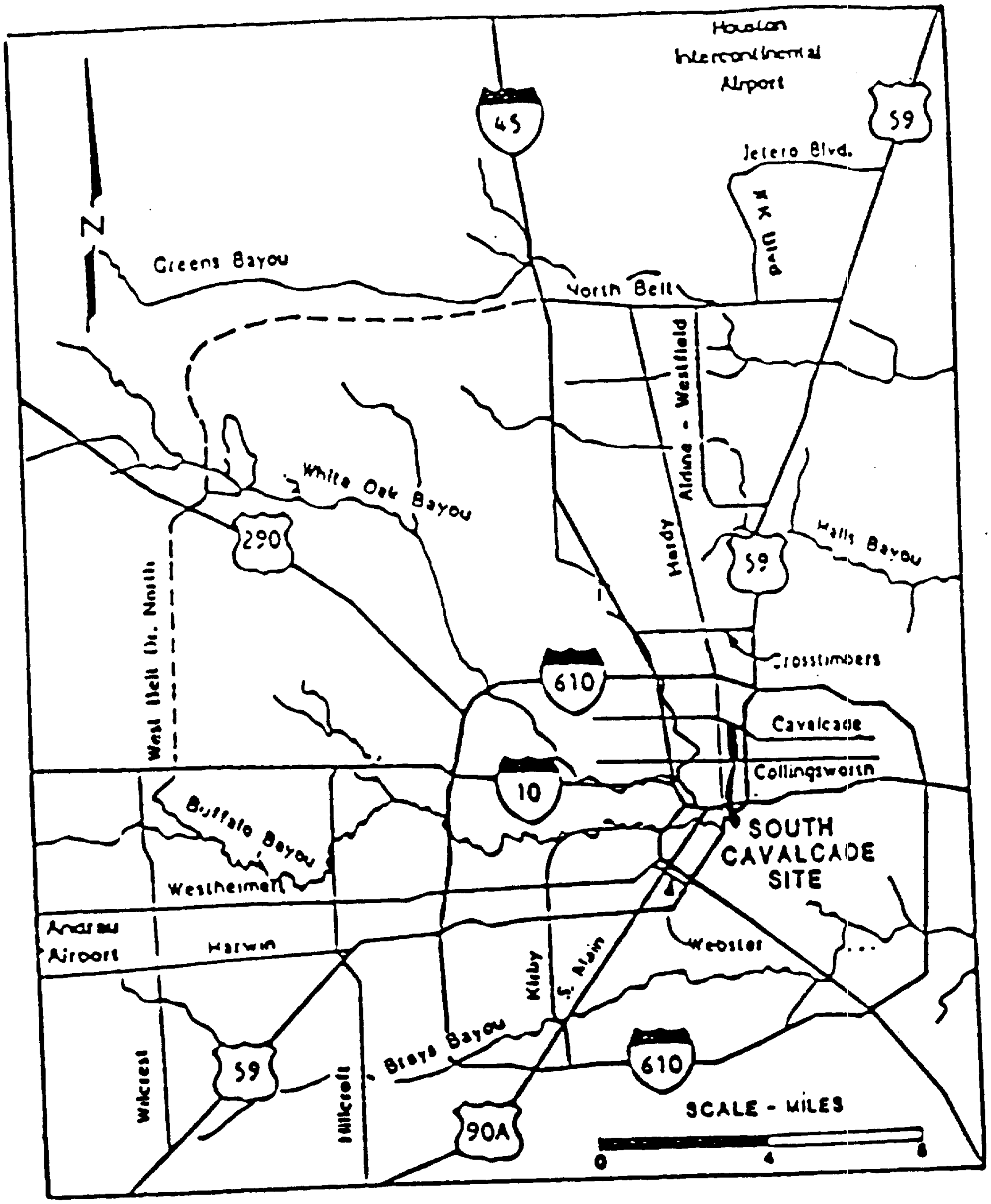

Fig. 3.1 Site Location Map

4.0 HAZARD ANALYSIS

This section describes the potential hazards and routes of exposure associated with the remedial design activities at the South Cavalcade Site and the respective risks to site personnel and the public.

4.1 POTENTIAL HAZARDS TO SITE WORKERS

This section describes the potential hazards and routes of exposure associated with the project tasks to the on-site workforce.

4.1.1 Site Preparation (Facilities, Utilities, Fencing)

Site preparation includes potentially dangerous tasks such as excavation of soil. These tasks may involve the handling of impacted materials. Other tasks, such as the removal of vegetation, generally involve the use of dangerous tools. Hazards associated with these tasks include:

- Heat or cold stress
- Fire
- Potential exposure to dangerous chemicals and/or biological environments
- Noise
- Safety hazards associated with heavy equipment
- Encountering buried or overhead utilities
- Electrocution
- Falling trees

Site preparations activities have a very low potential for exposure to the constituents of concern since activities take place outside the exclusion zone. However, there is a potential for exposure to constituents of concern. The possible routes may include exposure through skin contact with soil, ingestion of soil and inhalation of soil emissions.

4.1.2 Soil Sampling Activities

Characterization includes sampling of various media. Drilling operations at a site are often involved and could include the following hazards:

- Heat or cold stress
- Fire
- Potential exposure to dangerous chemicals and/or biological environments
- Noise
- Safety hazards associated with heavy equipment
- Encountering utilities such as electrical conduits.

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There is the potential for exposure to the constituents of concern during the soil sampling activities. The possible routes can be through skin contact with the soil or groundwater, splashing of the groundwater into eyes, ingestion of the soil or groundwater, or inhalation of soil emissions. The exposure potential will be minimized through the use of the proper personal protective equipment for the task.

4.1.2 Well Drilling

Wells may be impacted with site constituents. Several of these materials may create a hazardous environment during the drilling and installation of groundwater wells. Hazards associated with the tasks include:

- Heat or cold stress
- Potential exposure to dangerous chemicals and/or biological environments
- Noise
- Encountering buried utilities
- Spillage of materials with risk of migration to uncontrolled areas.

There is the potential for exposure to the constituents of concern during Well Drilling. The possible routes can be through skin contact with the groundwater or soil, splashing of the groundwater into eyes, ingestion of the groundwater or soil, or the inhalation of emissions from impacted soil or groundwater. The exposure potential will be minimized through the use of the proper personal protective equipment for the task.

4.1.4 Extraction Well Pilot Test

Wells may be impacted with site constituents. Several of these materials may create a hazardous environment within the head space of the well and/or in the general work area. Hazards associated with the tasks include:

- Heat or cold stress
- Potential exposure to dangerous chemicals and/or biological environments
- Noise
- Encountering buried utilities
- Spillage of materials with risk of migration to uncontrolled areas.

There is the potential for exposure to the constituents of concern during the Extraction Well Pilot Test. The possible routes can be through skin contact with the groundwater, splashing of the groundwater into eyes, ingestion of the groundwater, or the inhalation of emissions from impacted soil or groundwater. The exposure potential will be minimized through the use of the proper personal protective equipment for the task.

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4.1.5 Trench Drain Pilot Test

The excavation of the trench for the test and the flushing activities during the pilot test may present the following hazards:

- Heat or cold stress
- Uncovering and handling of buried containers
- Potential exposure to dangerous chemicals, and/or biological environments
- Encountering buried utilities
- Cave-in and sluffing associated with excavation
- Safety risks associated with the operation of heavy equipment.
- Confined space entry
- Noise exposure
- Spillage of materials with the risk of migration to uncontrolled areas.

There is the potential for exposure to the constituents of concern during the Trench Drain Pilot Test. The possible routes can be through skin contact with the soil or groundwater, splashing of the groundwater into eyes, ingestion of the soil or groundwater, or inhalation of soil or groundwater emissions. The exposure potential will be minimized through the use of the proper personal protective equipment for the task.

4.1.6 Soil Washing Pilot Test

The soil washing pilot test will consist of the multi-stage washing of the soils with the highest concentrations of potentially carcinogenic PAH's. The operations involved with the pilot test may have the following hazards present:

- Heat or cold stress
- Potential exposure to dangerous chemicals, and/or biological environments
- Safety risks associated with the operation of heavy equipment
- Noise exposure
- Spillage of materials with the risk of migration to uncontrolled areas.

There is the potential for exposure to the constituents of concern during the Soil Washing Pilot Test. The possible routes can be

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through skin contact with the soil or groundwater, splashing of the groundwater into eyes, ingestion of the soil or groundwater, or inhalation of soil or wash water emissions. The exposure potential will be minimized through the use of the proper personal protective equipment for the task.

4.1.7 Water Treatment Pilot Test

The water treatment pilot test will consist of the treatment of the water from the previous three pilot tests: the groundwater extraction well pilot test, the trench drain pilot test, and the effluent from the soil washing pilot test. Hazards that may be associated with the treatment and/or handling of the water:

- Heat or cold stress
- Potential exposure to biological environments
- Safety risks associated with the operation of heavy equipment
- Noise exposure
- Spillage of materials with the risk of migration to uncontrolled areas.

There is the potential for exposure to the constituents of concern during the Water Treatment Pilot Test. The possible routes can be through skin contact with the groundwater, splashing of the groundwater into eyes, ingestion of the groundwater, or the inhalation of groundwater emissions. The exposure potential will be minimized through the use of the proper personal protective equipment for the task.

4.1.8 Capping of Washed Soils

A cap will be installed to cover the areas that have been remediated. Hazards associated with the installation of the cap may include:

- Heat or cold stress
- Safety risks associated with the operation of heavy equipment
- Noise exposure

Capping of the Washed Soils will have a very low potential for exposure to constituents of concern since activities take place after the areas have been remediated. However, there is a potential for exposure to constituents of concern. The possible routes of exposure include skin contact and ingestion of the soil.

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4.2 BACKGROUND DATA

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This section presents the existing background data for each media of concern at the site.

4.2.1 Groundwater Analysis

A total of 55 samples were analyzed from two rounds of sampling of shallow groundwater from 20 wells installed during the Remedial Investigation and nine well installed during previous studies. These wells were installed in the shallow zone at depths between 17 and 57 feet.

Analysis of the shallow groundwater samples showed the presence of PAHs, NAPLs, and inorganics. No detection levels of any of these constituents were found in deep (210 - 221 ft.) monitoring wells. Table 4-1 summarizes the maximum chemical concentrations found in the shallow groundwater.

4.2.2 Surface and Surficial Analysis

Surface and surficial soils comprise the top six feet of soil at the South Cavalcade Site. Surface soils are defined to be in the upper 0.5 foot. Surface and surficial soils approximately delineate the unsaturated soils of the vadose zone.

Soil staining showing potential residual organic concentrations was seen at 15 of 139 auger boring locations and at 29 of 82 soil boring locations. Based on observations at these locations, a surficial soils quality map was developed to show the approximate aerial distributions of both surface and surficial visual soil staining.

Table 4-2 summarize the maximum chemical soil concentrations of samples analyzed for specific parameters taken from 0-6 feet and 6 feet and deeper.

4.2.3 Surface Water and Sediments

A total of 18 surface water samples were collected in drainage ditches which border the site and are within the property limits. Data from these samples are shown in Table 4-3. Surface water data indicate that no PAH compounds were detected, while volatile organics (acetone and methylene chloride) were detected at two sample locations. However, these two compounds are believed to be due to laboratory cross-contamination. Several metals were detected in surface water samples (arsenic, zinc, lead, iron,

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copper, and nickel), with only arsenic exceeding the maximum contaminant level (MCL).

Five sediment samples were collected and chemically analyzed from the drainage ditches. PAH components were detected in each sample, with concentrations ranging from 2.3 mg/kg to 236 mg/kg. The highest PAH concentration was detected in the southern end of the site and is apparently related to trucking activity there. Volatile organic compounds were also found, but were limited to acetone and methylene chloride, typical laboratory solvents. Detected sediment metal concentrations at all of the on-site sample locations were similar to background condition.

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TABLE 4-1
GROUNDWATER CONCENTRATIONS[1]

Contaminant	Maximum Concentration	Federal and State Standards[2]	BAT Monthly Discharge Limits[3]
Arsenic	522	50	
Chromium	450	50	1,110
Copper	1,340	1,000	1,450
Lead	260	50	320
Zinc	1,180	5,000	1,050
Benzene	930	5	57
Ethylbenzene	470	680	142
Toluene	1,000	2,000	28
Xylenes	1,100	440	
Acenaphthylene	610		19
Acenaphthene	2,600,000		19
Anthracene	550,000		19
Benzo(a)anthracene	500,000		19
Benzo(a)pyrene	570		20
Benzo(-b&k)fluoranthene	1,200		19
Benzo(g, h, i)pyrene	100		
Chrysene	1,600		19
Dibenzo(a, h)anthracene	nd[4]		
Fluoranthene	2,600,000		22
Fluorene	1,800,000		19
Ideno(1, 2, 3-cd)pyrene	nd		
2-Methylnaphthalene	1,300,000		
Naphthalene	7,100,000		19
Phenanthrene	4,900,000		19
Pyrene	1,900,000		20
Total PAHs	21,950,000		
Carcinogenic PAHs	500,000	0.003	

(1) units of micrograms per liter

(2) final and proposed primary and secondary drinking water standards except for 10.# risk level for carcinogenic PAHs

(3) Based on organic chemical, plastics, and synthetic fibers effluent guidelines for physical/chemical treatment

(4) nd = not detected

Note: All PAHs exceed the solubility constraint; data shows presence of non-aqueous phase liquid

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TABLE 4-2
SOIL CONCENTRATIONS [1]

Contaminant	Maximum Concentration Above 6 Ft.	Maximum Concentration Below 6 Ft.	Health Based Levels[2]
Arsenic	9	28	300
Chromium	10	47	>500,000
Copper	5	20	>500,000
Lead	30	45	420,000
Zinc	3,480	250	>500,000
Acenaphthylene	nd[3]		
Acenaphthene	440	570	
Anthracene	560	240	
Benzo(a)anthracene	340	93	
Benzo(a)pyrene	210	nd	
Benzo(-b&k)fluoranthene	290	61	
Benzo(g, h, i)pyrene	77	nd	
Chrysene	310	76	
Dibenzo(a, h)anthracene	na	nd	
Fluoranthene	1,600	420	
Fluorene	490	440	
Ideno(1, 2, 3-cd)pyrene	nd	nd	
2-Methylnaphthalene	68	780	
Naphthalene	950	1,900	
Phenanthrene	2,100	940	
Pyrene	1,200	280	
Total PAHs	8,567	5,020	
Carcinogenic PAHs	1,150	230	91

(1) units of mg/kg unless otherwise noted

(2) based on risk calculations for commercial exposure equal to the reference dose or 10^{-6} cancer risk

(3) na = not analyzed; nd = not detected

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TABLE 4-3
SURFACE WATER AND SEDIMENT CONCENTRATION[1]

Contaminant	Drainage Ditch Water	Drainage Ditch Sediments	Aquatic Water Standards[2]
Arsenic	56	30	360
Chromium	nd[3]	360	2,450
Copper	17	89	28
Lead	30	540	139
Zinc	140	3,300	167
Benzene	nd	nd	
Ethylbenzene	nd	nd	32,000
Toluene	nd	nd	17,500
Xylenes	nd	nd	
Acenaphthylene	nd	nd	
Acenaphthene	nd	nd	1,700
Anthracene	nd	nd	
Benzo(a)anthracene	nd	5.6	
Benzo(a)pyrene	nd	30	
Benzo(-b&k)fluoranthene	nd	59	
Benzo(g, h, i)pyrene	nd	41	
Chrysene	nd	10	
Dibenzo(a, h)anthracene	nd	nd	
Fluoranthene	nd	32	3,980
Fluorene	nd	nd	
Ideno(1, 2, 3-cd)pyrene	nd	30	
2-Methylnaphthalene	nd	nd	
Naphthalene	nd	nd	680
Phenanthrene	nd	nd	
Pyrene	nd	44	
Total PAHs	nd	236	
Carcinogenic PAHs	nd	170	

(1) units of mg/kg for sediments, micrograms/l for water

(2) based on Texas water quality standards for acute toxicity, and federal ambient criteria for those contaminants for which there are no state standards

(3) na = not analyzed; nd = not detected

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4.2.4 On-Site Airborne Concentrations

Two phenolic compounds were observed upwind of the site at concentrations equaling or exceeding downwind levels and at levels typical of the Houston area. No site related compounds were found.

4.3 EXPOSURE ASSESSMENT

An exposure pathway is a route a constituent may take to reach a susceptible receptor. In order for an exposure pathway to be complete, three factors must be present: (1) a source of impact (2) a route of constituent transport, and (3) a receptor that may be exposed to the constituents of concern.

Both the mode of exposure to environmental constituents and its duration influence resulting impacts. Primary modes of exposure include ingestion, inhalation, and dermal contact. Ingestion may occur either directly through drinking or eating impacted food and water, or indirectly through recreational and other uses of impacted water. Inhalation exposure results from breathing ambient air that has become impacted through volatilization, release of gas-phased constituents or entrainment of airborne respirable particulates. Since the size range for "respirable" particulates is very restricted, the physical size of the particulates as well as their chemical characteristics is important in determining the importance of the exposure.

Dermal exposure may result from direct contact with impacted water, soil, or other material. It also may involve indirect contact such as transfer of constituents from original sources to clothing and fixtures with subsequent skin contact.

Exposure durations are separated into two main classes: acute and chronic. Acute exposure involves single incidents or episodic frequency of short duration, and high concentrations of constituents . Chronic exposure implies long-term (months and years) continuous exposure, frequent intermittent exposure, or lifetime exposure (40 to 70 years) to low concentrations.

The potential for acute inhalation or dermal exposure is low at this site. Acute ingestion potential is also low at the Cavalcade Site. Chronic ingestion is the major exposure route at the site and is most likely to result from drinking impacted water.

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4.3.1 Sources of Impact

The apparent sources of impact at the Cavalcade Site lie primarily in the northeast and south to southeast region.

4.3.2 Routes of Constituent Transport

Constituent transport paths for potential exposure of human and environmental receptors in the vicinity of the Cavalcade Site are as follows:

- Precipitation and infiltration that leaches constituents of concern from surface deposition areas with subsequent off-site migration. Paved impacted areas reduce the potential for this type of exposure.

- Direct deposition in the groundwater with subsequent transport.

- Direct contact with drainage sediment resulting in adsorption, inhalation, and ingestion.

- Direct contact with surface soils resulting in adsorption, inhalation, and ingestion.

- Direct contact with the groundwater resulting in adsorption and ingestion.

Exposure to site constituents via the above pathways is a concern because some of the chemicals are potential carcinogens (i.e., benzene, arsenic, and benzo (a) pyrene) or are otherwise potentially hazardous to humans (xylenes, toluene, and other metals).

4.3.3 Summary

Based on present site conditions and data collected, potential receptors in the vicinity of Cavalcade Site include:

- On-site field investigation workers who may come into contact with or cause the release of volatiles in the soil (e.g., drillers, surveyors).

- Persons who may come into contact with impacted sediments in the stream.

The most likely on-site hazard is dermal exposure to constituents of concern in the soils and inhalation of chemical constituent if surface materials are disturbed.

The most susceptible receptors are considered to be site trespassers and field investigation personnel. Potential health

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impacts are low in this exposure mode primarily because of the time required to produce chronic effects.

Hazards associated with the site materials result from potential for exposure to the chemical constituents on-site. Chemical and physical consequences from acute or chronic exposures may include skin disorders, blood abnormalities, central nervous system damage, liver damage, edema, chemical asphyxiation, cancer and death. Potential pathways into the body (exposure routes) include inhalation, skin absorption and ingestion. The chemical substances and the concentrations present in groundwater, soils and surface water and sediments are provided in Tables 4-1, 4-2, 4-3, respectively.

Material Safety Data Sheets (MSDS) and other technical data (See Appendix B) for each identified chemical shall be on-site and used in training as required by the Hazard Communication Standard (see Section 10.7).

The degree of risk to personnel depends on the type of hazard, amount of material encountered, and the manner in which it is contacted.

Engineering and/or administrative controls and/or personnel protective equipment will be used to minimize exposure to site related chemicals. Work plans shall specify engineering controls to be used to reduce or eliminate exposure to harmful substances whenever practicable. The HSM and SHSO will identify administrative controls and specify personnel protective apparel and/or equipment to be provided and used when engineering controls cannot reduce airborne levels to below permissible limits or when the potential for exposure to constituents of concern exists.

5.0 RESTRICTED WORK AREAS

Restricted work areas will be established to control access and operations where exposure to hazardous materials may occur. Physical features of the site and designated boundaries shall be incorporated into the design of restricted work areas. These restricted areas will be determined by the level of constituents of concern present and the potential for exposure. Figure 5-1 shows the restricted work areas to be used.

Daily modification to the work zones will be performed as the work progresses. Restricted work areas and support zones will be established for each pilot test. These zones will be expanded or reduced as required by the work activity to each pilot test.

5.1 ACCESS CONTROL POINTS

Access control points shall be established for each of the project's designated restricted areas. These shall be maintained to control all ingress and egress from the restricted area and be designed to minimize personnel and vehicular traffic in the area, and control the spread of impacted materials into clean areas. These control points are subject to relocation according to the methods and work areas being used.

5.2 CONTAMINATION REDUCTION ZONE (CRZ)

A CRZ is the transition area between the impacted area and the non-impacted area. The CRZ is designed to reduce the probability that the clean "support zone" will become affected by other site hazards. Decon procedures take place in a designated area within the CRZ called the "contamination reduction corridor."

5.3 EXCLUSION ZONE

The exclusion zone is the area in which impact by the constituents of concern does or could occur. Personnel shall have a special objective for entering the zone. Personnel Protective Equipment (PPE) requirements may vary from area to area within the exclusion zone. The PPE required will depend on the activity being performed and the level of constituents of concern encountered.

Restricted Work Zones

Figure 5-1

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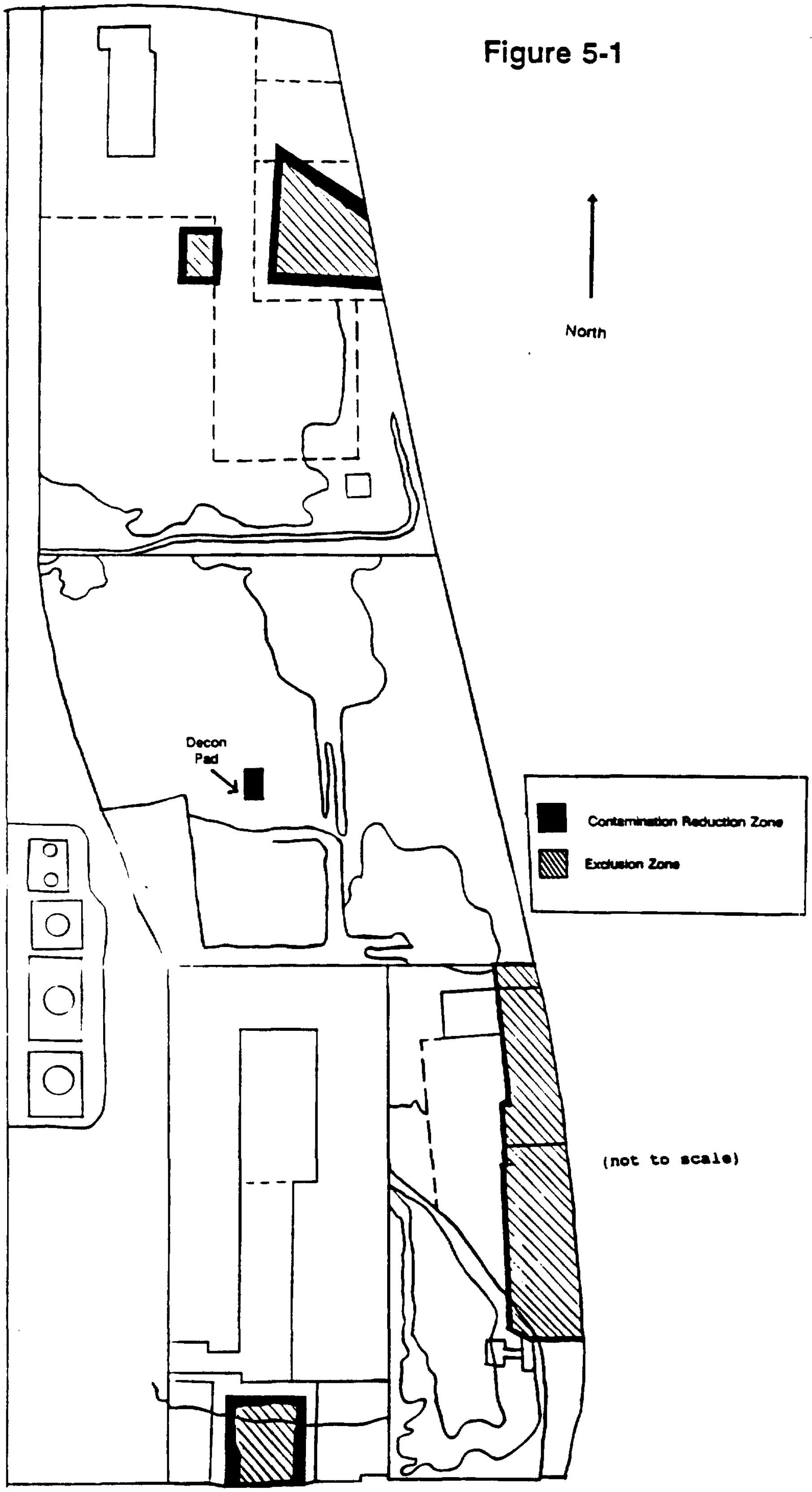

6.0 MEDICAL SURVEILLANCE

6.1 GENERAL

Personnel required to work in restricted work areas shall undergo a baseline medical evaluation meeting the contractor's criteria before participating in on-site operations.

The purpose of the medical surveillance program is to (1) assess the individual's health prior to work with impacted materials, (2) determine suitability for work assignments requiring the use of personal protective clothing and equipment, and (3) monitor for evidence of changes in medical indicators that could be related to the work. This assessment will investigate existing conditions that would predispose the employee to illness upon exposure to site related substances or from the physical demands exhibited while using personal protective equipment, such as respirators and protective clothing. A physician's statement, certifying that the employee is physically fit to work in a restricted area, shall be received by the SHSO before the employee begins to work.

6.2 BASELINE AND ANNUAL HEALTH ASSESSMENT

All personnel subject to occupational exposure at the site will be required to have had a medical assessment within the past twelve (12) months prior to the beginning of field operations.

The baseline and annual health assessment shall include a complete medical, family and occupational history; physical examination; selected biological sampling; laboratory studies including a complete blood count (CBC); urinalysis; chemistry panel (SMAC); pulmonary function testing (FEV1 and FVC); audiometry; and vision screening. Optional tests shall include a chest X-ray (PA); and electrocardiogram. Other tests deemed appropriate by the examining or consulting physician may be performed after consultation with the contractor.

6.3 SUPPLEMENTAL EXAMINATION

Any worker exposed to potentially harmful levels of site related materials shall undergo a supplemental examination if deemed appropriate by the examining or consulting physician.

6.4 BIOASSAY PROGRAM

Bioassay analysis may be conducted as described in the Medical Surveillance Program (Appendix A). Special bioassays for non-radioactive heavy metals and organic materials may be collected by the SHSO as directed by the HSM and the consulting occupational health physician based on the potential for employee exposure.

Samples will be collected and analyzed by recognized, standard procedures. Routine and special samples shall be collected as directed by the HSM and the physician. Results shall be reviewed by the HSM and physician.

7.0 MONITORING PROGRAM

7.1 MONITORING RATIONALE

Personal and area monitoring strategies will be developed to ensure the identification of areas and work activities for which engineering controls and/or personal protection are required. (Figure 7-1) Appendix F contains a set of guidelines for the selection of Personal Protective Equipment (PPE) based on the monitoring results from direct reading instruments. Monitoring shall be conducted to confirm that the levels of protection provided by the PPE and engineering controls are adequate to protect the worker, the environment, and the public.

Personal protective equipment shall be mandatory for tasks involving potential for exposure(s) unless monitoring results indicate that protection is not required.

Monitoring will include assessments of airborne constituents in work areas and at the site boundary. Direct reading monitoring instruments that will be used on site will include an Organic Vapor Analyzer (PID) and a Respirable Dust Monitor. Equipment adequate to meet monitoring needs shall be available, properly calibrated, and controlled.

7.1.1 Operations Involving Potential Exposure

Typical operations for which personnel monitoring (described in section 7.1.3) will be required include:

- Excavation of impacted material
- Soil testing
- Groundwater sampling
- Soil washing
- Water treatment
- Groundwater recovery

7.1.2 Health and Safety Plan - General Population

For the purpose of this plan, the "general population" will be defined as those individuals not associated with the field activities but in the proximity to these activities.

The Health and Safety Plan for these groups consist of:

1. Limiting the potential interaction with these groups; and

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AIR MONITORING DATA SHEET
DIRECT-READING

PAGE______ OF______

1 CLIENT	2 DATE
PERSON PERFORMING MONITORING (SIGNATURE)	
4 EMPLOYEE (NAME)	
5 EMPLOYEE NUMBER	6 WEATHER CONDITIONS / 7 PHOTO
8 SOCIAL SECURITY NUMBER	
9 PPE	10 INTERFERENCES
11 PROCESS	
	CONT'D.

DIRECT-READING DATA

12 INSTRUMENT NO.*	13 SUBSTANCE/AGENT	14 TIME	15 READING	16 LOCATION AND REMARKS

Figure 7-1

2. Instituting a system of "Perimeter Action Levels" based on air monitoring of the specific field activity, whereby organic vapor concentrations at the perimeter of work area are closely monitored to dictate health and safety actions.

7.1.2.1 Limiting Interactions

Visitors to the site will be required to report to a field headquarters and sign a visitors log book prior to entering the site. Depending on the purpose of the visit and the areas of the site to be visited, the SHSO or his/her designee will determine what personal protective equipment is required to be worn by the visitor.

7.1.2.2 Perimeter Monitoring

A survey will be taken at least hourly during the active movement of any impacted material, whether waters or soils. The survey will include perimeter points and work areas. A photoionization detector (PID) calibrated with isobutylene will be used to monitor both the perimeter and the work area. Locations used for data acquisition will be documented and indicated on a dated site layout drawing in such a manner that the information can be related to the operations in progress. Documentation of the pre- and post-use calibration of the PID, according to the manufacturer's directions, isobutylene calibration standards will be maintained by the SHSO.

7.1.2.3 Perimeter Action Levels

When field personnel observe a sustained organic vapor reading in excess of 10 ppm (above background) as measured in the workers breathing zone, field personnel will take another measurement downwind at the field activity perimeter. Instruments will be read manually rather than to rely on unattended systems. The instruments used will be equipped with an alarm with the alarm set point triggering at 10 ppm. During active operations, readings will be taken and documented hourly; more often if the SHSO determines that the conditions or the task increases the potential for elevated readings.

The following responses will be initiated dependent upon the sustained organic vapor reading (based on a PEL of 10 ppm for naphthalene which is the most volatile material present):

- < 10 ppm above background: Notify Project Manager and keep him/her apprised of status. Continue to work.

- 10 ppm above background: Alert field personnel in the vicinity. Require MSHA/NIOSH approved respirators with OV/AG/HEPA cartridge filters on all personnel downwind of the work area if they are to continue to work downwind. Instrument readings will be taken downwind to document readings, but the level of respiratory protection will not be downgraded until the workplace readings drop below 10 ppm. Monitor at the perimeter on a continuous basis until the condition has subsided.

- 50 ppm or greater above background: Suspend all field activities, notify Project Manager. If concentrations greater than 100 ppm above background persist after the operations are suspended, the SHSO will notify the Project Manager and the source of the organic vapor will be investigated. Appropriate actions will be determined and acted upon on a case by case occurrence by Beazer East Inc., and its contractor.

Extensive weather monitoring will not be required on-site. Wind socks will be placed in the vicinity of each Exclusion Zone to provide wind directional information to the personnel working in the immediate area. If the wind direction should change, then the locations for the downwind perimeter readings will be moved to compensate for the new wind direction.

7.1.3 Personnel Monitoring

Air quality monitoring will be performed to measure worker exposure. Within the work area, organic vapor measurements and dust monitoring (when visual observations indicate the need) at the breathing zone will be used as an indication of airborne contaminant levels. PID's and a dust monitor will be used to gather real-time data. Action levels have been established and responses to those action levels have been devised.

7.2 INSTRUMENTATION

The HSM and SHSO shall ensure that an adequate supply of monitoring equipment is available before the start of work. The SHSO shall ensure that the instruments are used only by persons with training.

To help evaluate potential health hazards at the site, the SHSO shall supervise the use of monitoring equipment (action levels are listed in Appendix F) such as the following:

- Photoionization Detector (PID) - This instrument shall be calibrated and operated according to the manufacturer's specifications. The instrument shall be calibrated at least daily.

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- Respirable Dust Monitor - This instrument shall be calibrated and operated according to the manufacturer's specifications. The instrument shall be calibrated at least daily.

- High-flow air sampling pumps - These instruments shall be calibrated according to the manufacturer's specifications and federal, state or local regulatory requirements.

- Personnel air sampling pumps - These instruments shall be calibrated before and after each use and according to federal, state and local regulatory requirements.

- Draeger detector tube assembly - This instrument shall be leak-checked daily or before each use as needed.

A copy of calibration records shall be maintained by the SHSO for all instrument calibrations performed by manufacturers and other parties. Calibration data shall be recorded on field data collection forms. Air sampling pumps shall be calibrated with primary standards or pre-calibrated secondary standards before and after each use to ensure accuracy in determining samples air volumes.

8.0 PERSONNEL PROTECTIVE APPAREL AND EQUIPMENT

The specific PPE that will be used includes, but is not limited to:

- White hooded regular Tyvek coveralls
- Work boots worn with protective rubber overshoes
- Eye protection goggles whenever there is potential for exposure to flying objects and dust
- Safety helmets (hard hats) and glasses to be worn by all workers at all times
- Ear plugs or ear muffs for protection against noise levels exceeding permissible limits
- Full-face negative pressure respirators
- Rubber gloves

A modified level D using protective coveralls, boots and gloves should be sufficient for most activities. Personal protective equipment (PPE) levels may be up or downgraded based on monitoring and surveillance results. PPE levels will be immediately increased by the SHSO should monitoring results indicate the need. The HSM will be consulted before downgrading the level of PPE for a particular area or activity.

Site work zones will be set up to determine the level of PPE to be worn in each area on site. Exclusion zones will require the use of PPE. Different levels of PPE may be required in different areas of the exclusion zone, depending on types and levels of constituents of concern. Areas and boundaries of work zones will change as work progresses. Updated copies of the work zones shall be posted and all site personnel made aware of them.

Additional controls will include providing laundered, cloth coveralls and a change room for employees working on-site. Toilet facilities and a lunch-room outside the restricted area will also be provided. Good hygiene practices will be enforced. Engineering controls will be employed for the reduction of materials released to the atmosphere. These controls may include water for dust control and limiting the area exposed if necessary.

8.1 APPAREL SELECTION

The protective apparel and equipment requirements for personnel working in restricted work areas shall be determined by the SHSO after consultation with the HSM or his designee.

Site workers will initially utilize modified Level D protection. As work progresses, it is expected that full Level C protection may be necessary. Variations in site conditions (e.g., excavation locations) and monitoring conducted by the SHSO will determine upgrades or downgrades of PPE requirements. Personal protective equipment will be based on four levels of protection (Levels A through D). Equipment used shall be recognized by other approving authorities (i.e., NIOSH, NRC, NFPA, etc.). The level of protection shall be based on the type of chemical material, its concentration and toxicity and the potential for exposure through ingestion, inhalation, skin absorption, direct contact, splash, or impact. The levels of protection are described below.

LEVEL A - Provides the highest available level of respiratory, skin, and eye protection.

- Required equipment includes a pressure-demand, full-facepiece SCBA or pressure-demand supplied-air respirator with escape SCBA, fully-encapsulating, chemical-resistant suit, inner chemical-resistant gloves, chemical-resistant safety boots/shoes, and an intrinsically safe two-way radio, to be worn inside the suit (Figure 8-1).

LEVEL B - Provides the same level of respiratory protection as level A, but less skin protection.

- Required equipment includes a pressure-demand, full-facepiece SCBA or pressure-demand supplied-air respirator with escape SCBA, chemical-resistant clothing (overalls and long sleeved jacket; hooded one-, or two-piece chemical-resistant splash suit; disposable chemical-resistant one-piece suit), inner and outer chemical-resistant gloves, chemical-resistant boots/shoes, hard hat, and two-way radio (Figures 8-2).

LEVEL C - For use when the substance(s) and concentration(s) are known and the criteria for using air purifying respirators can be met. Level C provides the same level of skin protection as level B, but a lower level of respiratory protection.

- Required equipment includes a full-facepiece, air-purifying canister-equipped respirator, chemical-resistant clothing (overalls and long sleeved jacket; hooded, one-, or two-piece chemical-resistant splash suit; disposable chemical-resistant one-piece suit), inner and outer chemical-resistant gloves, chemical-resistant boots/shoes, hard hat, and two-way radio (Figure 8-3).

LEVEL D - Provides no respiratory protection and minimal skin protection (Figure 8-4).

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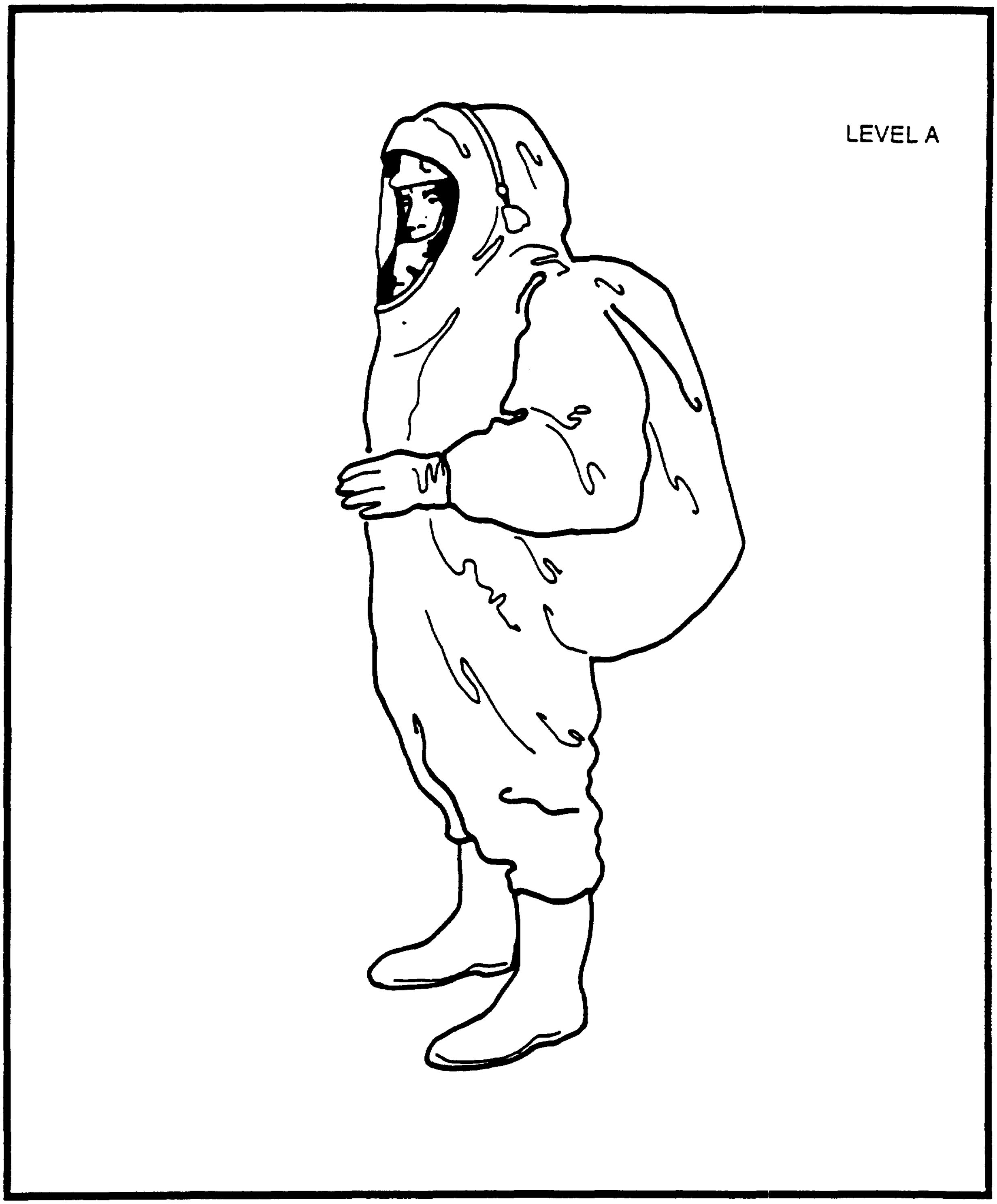

FIGURE 8-1 LEVEL A – POSITIVE PRESSURE SCBA, CHEMICALLY RESISTANT ENCAPSULATED SUIT, INNER AND OUTER GLOVES, AND TWO-WAY RADIO

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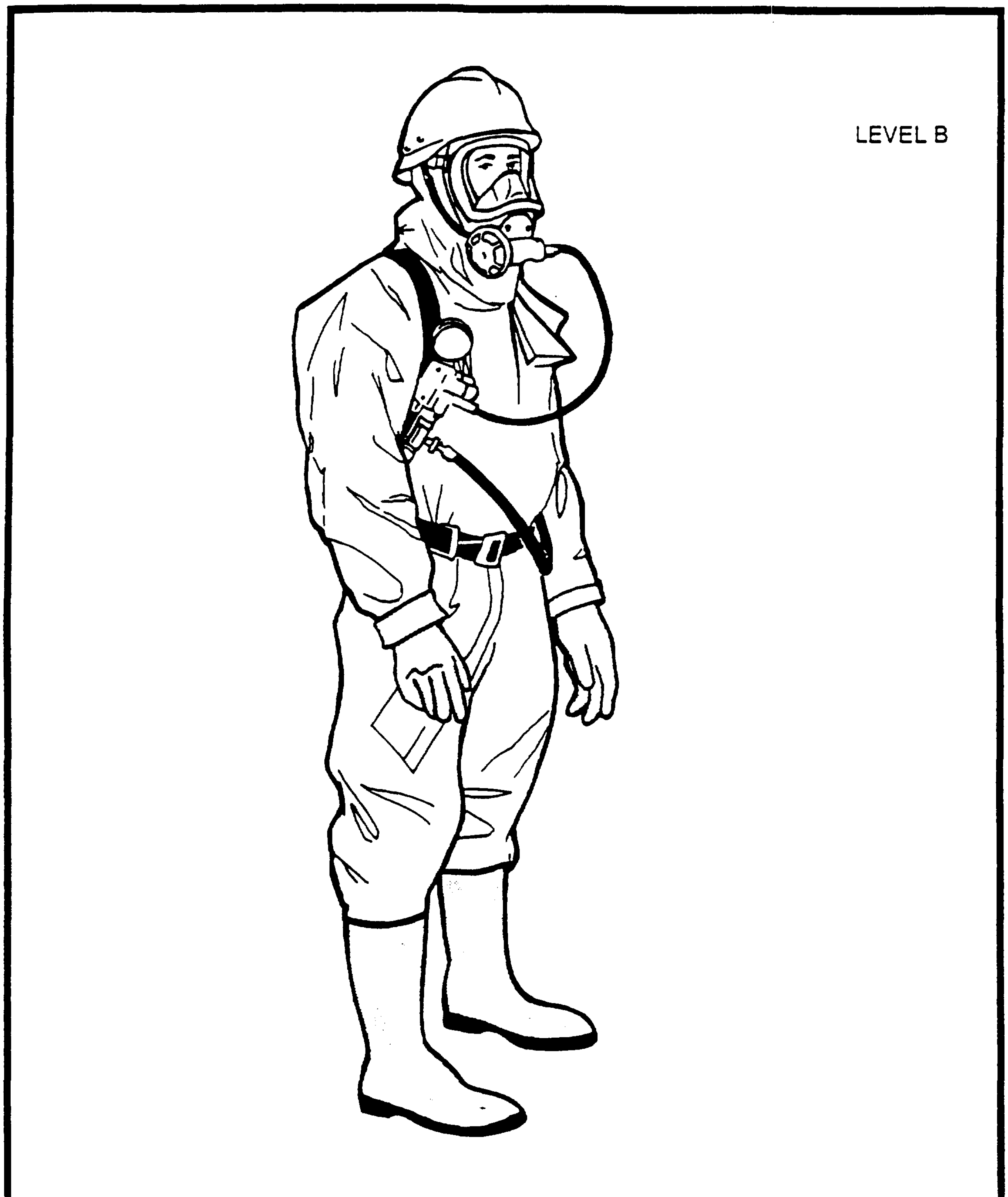

FIGURE 8-2 LEVEL B – POSITIVE PRESSURE SCBA, HOODED DISPOSABLE COVERALLS, RUBBER BOOTS, GLOVES, AND RADIO (ALL CONNECTING POINTS SHALL BE TAPED)

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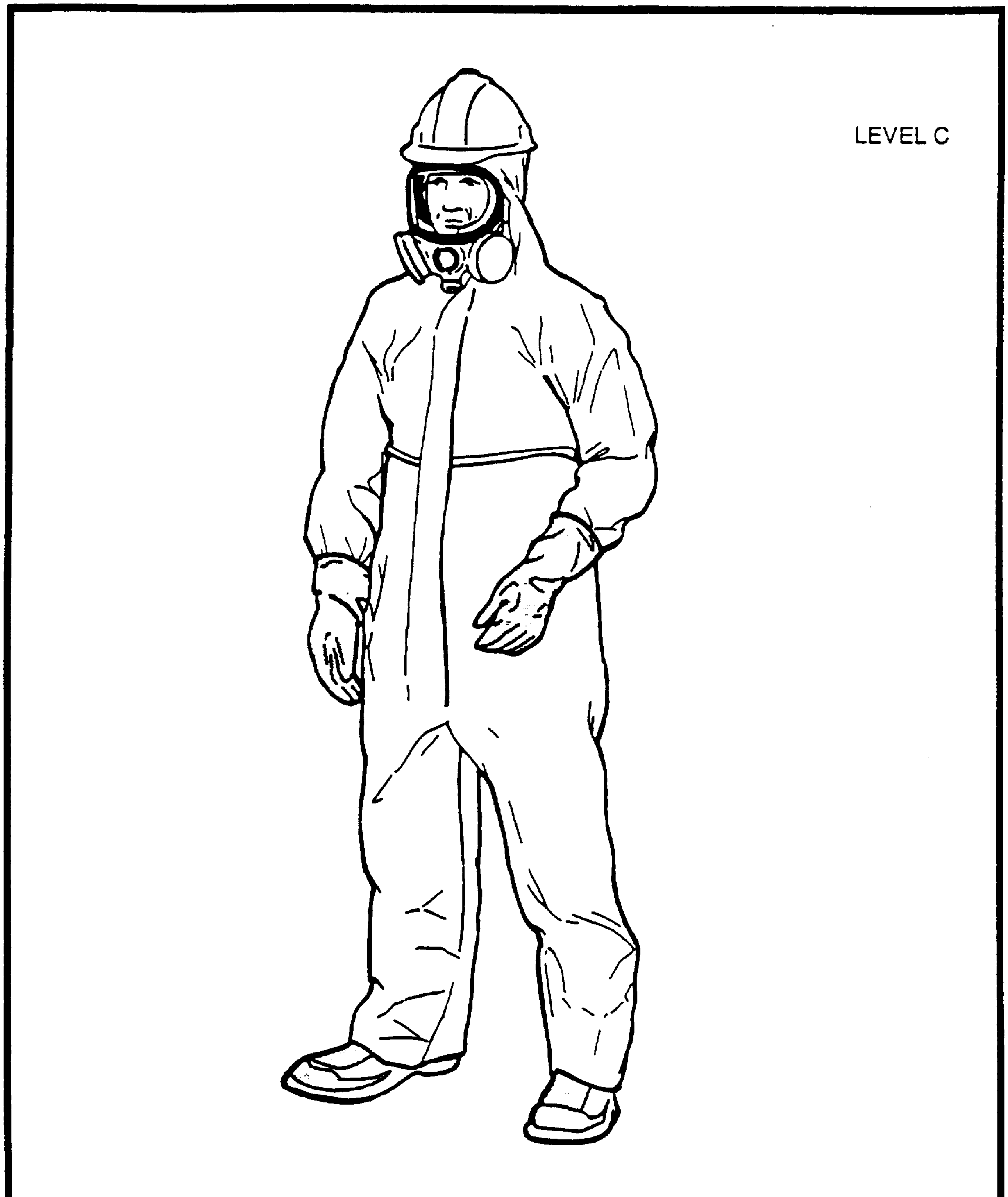

FIGURE 8-3 LEVEL C – NEGATIVE PRESSURE RESPIRATOR, DISPOSABLE COVERALLS, RUBBER BOOTS, GLOVES, AND HARD HAT

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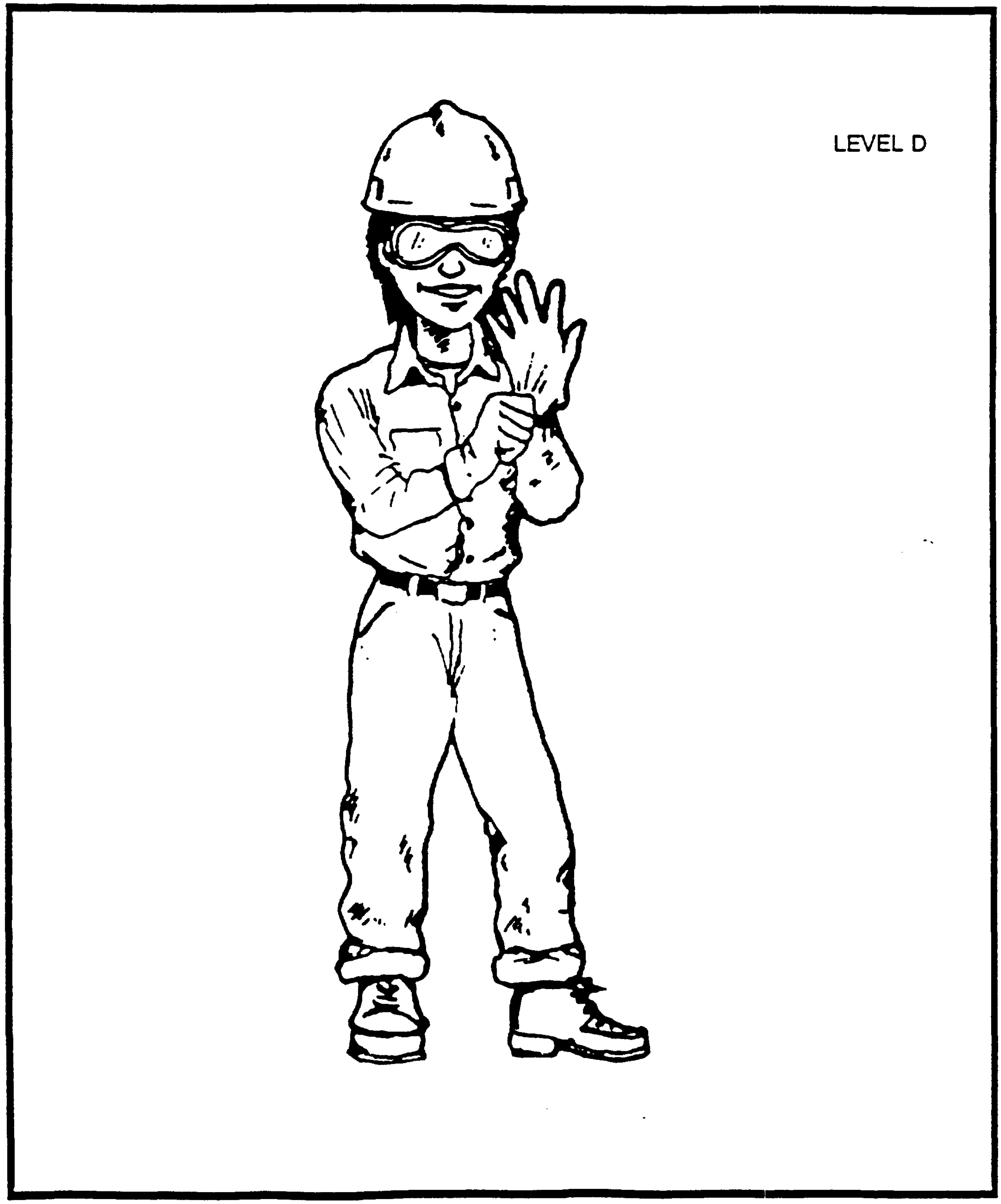

FIGURE 8-4 LEVEL D - HARD HAT, SAFETY GLASSES, AND SAFETY SHOES/BOOTS

- Required equipment includes standard work clothes or coveralls, safety boots/shoes, safety glasses or chemical splash goggles, and a hard hat. An escape mask is optional, to be used if there is a potential for a sudden release of vapors that would force personnel to evacuate the area.

Any of the levels of protection can be modified to include other protective equipment in addition to the required equipment for the specified level of protection. For example, Level D protection can be increased to a modified Level D by adding chemical-resistant gloves and chemical-resistant clothing. Since the equipment does not satisfy the minimum required equipment for Level C, this type of upgrade in protection will be referred to as modification of the lower level.

PPE can reduce the possibility of contact with site-related constituents materials, but it should be used in conjunction with proper site entry protocols and other safety considerations. No single combination of protective apparel is capable of protecting against all hazards. The use of protective apparel and equipment can create significant hazards (e.g., heat/cold stress; physical and psychological stress; impaired vision, mobility and communications, etc.). For any given situation, apparel and equipment should be selected to provide a level of protection commensurate with the degree of potential hazard. Over-protection, as well as under-protection, can be hazardous and should be avoided.

Protective apparel and equipment should be selected using the following criteria:

- Permeability, degradability, penetrability
- Heat/cold transfer characteristics
- Durability
- Flexibility
- Temperature effects
- Ease of decontamination
- Compatibility with other equipment
- Duration of use
- Special conditions (fire, explosion, electrical, radiation and confined spaces)
- Value (thermal insulation value)

Generally, a modified Level D protection will be worn in restricted work areas. This level of protection will be upgraded if monitoring indicates a more stringent control is required.

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8.2 TASK SPECIFIC PPE GUIDELINES

8.2.1 <u>Site Preparation - Mobilization including the setup of facilities, utilities</u>

Primary Level of Protection:	Level D
Contingency Level of Protection:	Modified D
Type of Work:	Non-Intrusive
Schedule:	To be determined

Personnel Protection -- Engineering Controls

Well illuminated environment

Personal Protection -- Administrative Controls

1. No work in electrical storms
2. Operator Training
3. Initial air monitoring

Personnel Protective Equipment

Level D (Primary)

1.	Respiratory Protection:	None
2.	Protective Clothing:	Standard work clothes
3.	Head & Eye/Ear Protection:	Hard hat/safety glasses/ear plugs, when required
4.	Foot Protection:	Work shoes
5.	Hand Protection:	Work gloves

COMMENTS: The SHSO will determine the level of protection based on instrumentation and site conditions.

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8.2.2 Well Drilling

Primary Level of Protection:	Modified D
Contingency Level of Protection:	Level C
Type of Work:	Intrusive
Schedule:	To be determined

Personnel Protection -- Engineering Controls

Well illuminated environment

Personal Protection -- Administrative Controls

1. Hazardous waste site training
2. No work in electrical storms
3. Medically qualified
4. Respirator qualified
5. Air monitoring
6. Operator Training
7. Establish control area and control points

Personnel Protective Equipment

Modified Level D (Primary)

1.	Respiratory Protection:	None
2.	Protective Clothing:	Coveralls
3.	Head & Eye/Ear Protection:	Hard hat/safety glasses/ear plugs, when required
4.	Foot Protection:	Chemical resistant boots
5.	Hand Protection:	Nitrile inner & outer gloves

COMMENTS: The SHSO will determine the level of protection based on instrumentation and site conditions.

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8.2.3 Soil Sampling - Characterization activities which include the sampling of various media.

Primary Level of Protection: Modified D

Contingency Level of Protection: Level C

Type of Work: Intrusive

Schedule: To be determined

Personnel Protection -- Engineering Controls

Well illuminated environment

Personal Protection -- Administrative Controls

1. Hazardous waste site training
2. No work in electrical storms
3. Medically qualified
4. Respirator qualified
5. Air monitoring
6. Operator Training
7. Establish control area and control points

Personnel Protective Equipment

Modified Level D (Primary)

1.	Respiratory Protection:	None
2.	Protective Clothing:	Coveralls
3.	Head & Eye/Ear Protection:	Hard hat/safety glasses/ear plugs, when required
4.	Foot Protection:	Chemical resistant boots
5.	Hand Protection:	Nitrile inner & outer gloves

COMMENTS: The SHSO will determine the level of protection based on instrumentation and site conditions.

8.2.4 Extraction Well Pilot Test

Primary Level of Protection:	Level D
Contingency Level of Protection:	Modified D
Type of Work:	Intrusive
Schedule:	To be determined

Personnel Protection -- Engineering Controls

Well illuminated environment

Personal Protection -- Administrative Controls

1. Operator Training
2. Initial air monitoring

Personnel Protective Equipment

Level D (Primary)

1.	Respiratory Protection:	None
2.	Protective Clothing:	Standard work clothes
3.	Head & Eye/Ear Protection:	Hard hat/safety glasses/ear plugs, when required
4.	Foot Protection:	Work shoes
5.	Hand Protection:	Work gloves

COMMENTS: The SHSO will determine the level of protection based on instrumentation and site conditions.

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8.2.5 Trench Drain Pilot Test

Primary Level of Protection:	Level D
Contingency Level of Protection:	Level C
Type of Work:	Intrusive
Schedule:	To be determined

Personnel Protection -- Engineering Controls

Well illuminated environment

Personal Protection -- Administrative Controls

1. Hazardous waste site training
2. No work in electrical storms
3. Medically qualified
4. Respirator qualified
5. Air monitoring
6. Operator Training
7. Establish control area and control points

Personnel Protective Equipment

Level D (Primary)

1.	Respiratory Protection:	None
2.	Protective Clothing:	Coveralls
3.	Head & Eye/Ear Protection:	Hard hat/safety glasses/ear plugs, when required
4.	Foot Protection:	Work boots
5.	Hand Protection:	Work gloves

COMMENTS: The SHSO will determine the level of protection based on instrumentation and site conditions.

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8.2.6 Soil Washing Pilot Test

Primary Level of Protection:	Level D
Contingency Level of Protection:	Level C
Type of Work:	Intrusive
Schedule:	To be determined

Personnel Protection -- Engineering Controls

Well illuminated environment

Personal Protection -- Administrative Controls

1. Hazardous waste site training
2. No work in electrical storms
3. Medically qualified
4. Respirator qualified
5. Air monitoring
6. Operator Training
7. Establish control area and control points

Personnel Protective Equipment

Level D (Primary)

1.	Respiratory Protection:	None
2.	Protective Clothing:	Coveralls
3.	Head & Eye/Ear Protection:	Hard hat/safety glasses/ear plugs, when required
4.	Foot Protection:	Work boots
5.	Hand Protection:	Work gloves

COMMENTS: The SHSO will determine the level of protection based on instrumentation and site conditions.

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8.2.7 Water Treatment Pilot Test

Primary Level of Protection:	Level D
Contingency Level of Protection:	Level C
Type of Work:	Intrusive
Schedule:	To be determined

Personnel Protection -- Engineering Controls

Well illuminated environment

Personal Protection -- Administrative Controls

1. Hazardous waste site training
2. No work in electrical storms
3. Medically qualified
4. Respirator qualified
5. Air monitoring
6. Operator Training
7. Establish control area and control points

Personnel Protective Equipment

Level D (Primary)

1.	Respiratory Protection:	None
2.	Protective Clothing:	Coveralls
3.	Head & Eye/Ear Protection:	Hard hat/safety glasses/ear plugs, when required
4.	Foot Protection:	Work boots
5.	Hand Protection:	Work gloves

COMMENTS: The SHSO will determine the level of protection based on instrumentation and site conditions.

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8.2.8 Capping of Washed Soils

Primary Level of Protection:	Level D
Contingency Level of Protection:	Modified D
Type of Work:	Non-Intrusive
Schedule:	To be determined

Personnel Protection -- Engineering Controls

Well illuminated environment

Personal Protection -- Administrative Controls

1. Operator Training
2. Initial air monitoring

Personnel Protective Equipment

Level D (Primary)

1.	Respiratory Protection:	None
2.	Protective Clothing:	Standard work clothes
3.	Head & Eye/Ear Protection:	Hard hat/safety glasses/ear plugs, when required
4.	Foot Protection:	Work shoes
5.	Hand Protection:	Work gloves

COMMENTS: The SHSO will determine the level of protection based on instrumentation and site conditions.

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8.3 PROTECTIVE CLOTHING/EQUIPMENT

Items specified below are intended to allow the SHSO the flexibility to provide a range of protection based upon actual working conditions. The SHSO shall ensure that all field workers have the following clothing/equipment available for their use as required.

8.3.1 Hand Protection

To protect hands and arms from chemical contact, impermeable gloves shall be used as integral, attached, or separate items from other protective clothing. Latex gloves or N-Dex Nitrile gloves will be used as an inner glove. Outer gloves will be medium length nitrile gloves.

8.3.2 Body Clothing

Various types of body clothing are designed to prevent contact with the body by chemical substances. Poly-coated Tyvek coveralls shall be used for most work; however, the following clothing typically will be available on-site:

- Chemical protective tyvek suits
- Rain suits

Acid suits shall be used in place of tyvek coveralls when working in areas where there is contact with acids or caustics (pH less than or equal to 3 and greater than or equal to 9).

8.3.3 Respiratory Protection

Respiratory protection is discussed in Section 9.0. The cartridges that will be used with the air purifying respirators shall be NIOSH approved organic vapor/acid gas/HEPA cartridges.

8.3.4 Foot Protection

Work boots shall be worn to protect feet from contact with chemicals, compression, crushing or puncture. Foot covers, made of a variety of materials, protect boots from contact and protect feet from chemicals. Foot covers may be disposable.

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8.3.5 Eye and Face Protection

Employees shall wear approved eye protection (i.e., safety glasses, goggles, face shield, etc.) when they are exposed to:

- Flying objects
- Dust
- Chemicals

Face shield and chemical splash-proof goggles shall be worn when the face and eyes are vulnerable to acidic or caustic material, or as directed by the SHSO.

8.3.6 Head Protection

Safety helmets (hard hats), helmet liners, hoods and protective hair coverings shall be used to protect the head from impact, chemical splashes and entanglement of hair in machinery or equipment. Industrial safety hard hats shall be worn by all workers at all times, except in designated areas.

8.3.7 Noise Protection

When noise levels exceed acceptable levels, as specified in 29 CFR 1910.95 engineering controls shall be used to reduce the exposures. If this cannot be done, approved protective equipment (i.e., ear plugs, ear muffs, etc.) shall be provided and its use enforced by the SHSO.

8.4 HEAT STRESS

Stress can contribute significantly to accidents or harm workers in other ways.

The term stress denotes the physical (gravity, mechanical force, heat, cold, pathogen, injury) and psychological (fear, anxiety, crises, joy) forces that are experienced by individuals. The body's response to stress occurs in three stages:

- Alarm reaction in which the body recognizes the stressor and the pituitary-adreno-cortical system responds by increasing the heart rate and blood sugar level, decreasing digestive activity, and dilating the pupils.
- Adaptive stage in which the body repairs effect of stimulation and the stress symptoms disappear.

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- Exhaustive stage in which the body can no longer adapt to stress and individual may develop emotional disturbances, and cardiovascular and renal diseases.

One of the most common types of stress that can affect field personnel is heat stress. Current thinking is that heat stress may be the most serious hazard to workers at remedial sites.

8.4.1 Causes and Preventative Measures

Heat stress usually is a result of protective clothing decreasing natural body ventilation and therefore cooling; however, it may occur at any time work is being performed at elevated temperatures.

If the body's physiological processes fail to maintain a normal body temperature because of excessive heat, a number of physical reactions can occur ranging from mild (such as fatigue, irritability, anxiety, and decreased concentration, dexterity, or movement) to fatal. Because heat stress is one of the most common and potentially serious illnesses that site workers encounter, regular monitoring and other preventative measures are vital.

Site workers must learn to recognize and treat the various forms of heat stress.

The best approach is preventative heat stress management. In general:

- Have workers drink 16 ounces of water before beginning work, such as in the morning or after lunch. Provide disposable 4-ounce cups, and water. Urge workers to drink 1-2 of these cups every 20 minutes, for a total of 1-2 gallons per day. Provide a cool, preferably air-conditioned area for rest breaks. Discourage the use of alcohol in non-working hours, and discourage the intake of coffee during working hours. Monitor for signs of heat stress. If an individual has high blood pressure, they must be monitored more often and take precautions (i.e., drink more water).

- Acclimate workers to site work conditions by slowly increasing workloads, i.e., do not begin site work activities with extremely demanding activities.

- Provide cooling devices to aid natural body ventilation. These devices, however, add weight, and their use should be balanced against worker efficiency. An example of a cooling aid is long cotton underwear which acts as a wick to help absorb moisture and protect the skin from direct contact with heat-absorbing protective clothing.

- Install showers and/or hose-down facilities to reduce body temperature and cool protective clothing.

- Ensure that adequate shelter is available to protect personnel against heat, as well as cold, rain, snow, etc., which can decrease physical efficiency and increase the probability of both heat and cold stress. If possible, set up the command post in the shade.

- In hot weather, rotate shifts of workers wearing impervious clothing.

- Good hygienic standards must be maintained by frequent changes of clothing and showering. Clothing should be permitted to dry during rest periods. Persons who notice skin problems should immediately consult medical personnel.

8.4.2 Physiological Responses

One of the most significant physical stresses which could be encountered by workers is heat stress. Heat stress is a result of an elevation of body core temperature above 37.C (98.6.F). As the result of a temperature imbalance between the body and environment, a net buildup of heat in the body occurs. Heat-related illnesses include: heat stroke, heat exhaustion, heat cramps and heat rash.

Heat Stroke. Heat stroke is an acute and dangerous reaction to heat stress caused by a failure of heat regulating mechanisms of the body -- the individual's temperature control system that causes sweating stops working correctly. Body temperature rises so high that brain damage and death will result if the person is not cooled quickly.

- Symptoms: Red, hot, dry skin, although person may have been sweating earlier; nausea; dizziness; confusion; extremely high body temperature, rapid respiratory and pulse rate; unconsciousness or coma.

- Treatment: Cool the victim quickly. If the body temperature is not brought down fast, permanent brain damage or death will result. Soak the victim in cool but not cold water, sponge the body with cool water or pour water on the body to reduce the temperature to a safe level (102°F). Observe the victim and obtain medical help. Do not give coffee, tea, or alcoholic beverages.

Heat Exhaustion. Heat exhaustion is a state of very definite weakness or exhaustion caused by the loss of fluids from the body. This condition is much less dangerous than heat stroke, but it nonetheless must be treated.

- Symptoms: Pale, clammy, moist skin, profuse perspiration and extreme weakness. Body temperature is normal, pulse is weak and rapid, breathing is shallow. The person may have a headache, may vomit, and may be dizzy.

- Treatment: Remove the person to a cool, air-conditioned place, loosen clothing, place in a head-low position and provide bed rest. Consult physician, especially in severe cases. The normal thirst mechanism is not sensitive enough to ensure body fluid replacement. Have patient drink 1-2 cups of water immediately, and every 20 minutes thereafter until symptoms subside. Total water consumption should be about 1-2 gallons per day.

<u>Heat Cramps.</u> Heat cramps are caused by perspiration that is not balanced by adequate fluid intake. Heat cramps are often the first sign of a condition that can lead to heat stroke.

- Symptoms: Acute painful spasms of voluntary muscles; e.g., abdomen and extremities.

- Treatment: Remove victim to a cool area and loosen clothing. Have patient drink 1-2 cups of water immediately, and every 20 minutes thereafter, until symptoms subside. Total water consumption should be 1-2 gallons per day. Consult with physician.

<u>Heat Rash.</u> Heat rash is caused by continuous exposure to heat and humid air and aggravated by chafing clothes. The condition decreases ability to tolerate heat.

- Symptoms: Mild red rash, especially in areas of the body in contact with protective gear.

- Treatment: Decrease amount of time in protective gear and provide powder to help absorb moisture and decrease chafing.

During warm weather, environmental temperatures will be monitored for all field project activity. American Conference of Governmental Industrial Hygienists (ACGIH) recommendations will be followed. Environmental factors are to be measured by the Wet Bulb Globe Temperature Index (WBGT). Physiological monitoring will be instituted if ambient air temperature exceeds 70°F, for workers outfitted in protective Levels A through C. As a minimum, worker's body temperature and heart rate measurements may be taken following guidelines contained in Section 8.4.3.

Workers required to wear protective clothing may be required to adjust work activities according to the work cycle management schedule (contained in Section 8.4.3) which is based on the adjusted temperature: (T adj = T actual + 13 X Fraction Sunshine).

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8.4.3 Heat Stress Monitoring and Work Cycle Management

For strenuous field activities that are part of on-going site work activities in hot weather, the following procedures may be used to monitor the body's physiological response to heat and to manage the work cycle. These procedures may be instituted when the temperature exceeds 70°F.

Measure Heart Rate (HR). Heart rate should be measured by the radial pulse for 30 seconds as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 110 beats/minute for most individuals. The maximum rate is based on an individual's base rate. Base rates vary across the population. If the HR is higher, the next work period should be shortened by 33 percent, while the length of the rest period stays the same. If the pulse rate still exceeds 110 beats/minute at the beginning of the next rest period, the following work cycle should be further shortened by 33 percent. The procedure is continued until the rate is maintained below 110 beats/minute.

Manage Work/Rest Schedule. The following work/rest schedule may be used as a guideline:

Adjusted Temperature F°	Active Work Time (min/hr) Using Level B/C Protective Gear
75 or less	50
80	40
85	30
90	20
95	10
100	0

Calculate the adjusted temperature:

T (adjusted) = T (actual) + (13 X fraction sunshine)

Measure the air temperature with a standard thermometer. Estimate fraction of sunshine by judging what percent the sun is out: 100% sunshine = no cloud cover = 1.0; 50% sunshine = 50% cloud cover = 0.5; 0% sunshine = full cloud cover = 0.0.

The work cycle may be reduced or increased according to the guidelines under heart rate.

9.0 RESPIRATORY PROTECTION

9.1 MEDICAL REQUIREMENTS

The medical surveillance program as specified in Section 6.0 applies to all prospective site workers. It determines if a worker is physically qualified for the work, establishes the prospective worker's present health conditions and determines whether there would be any limitations on work assignments for that worker.

One of the tests performed during the medical examination to assist employers in selecting workers is the pulmonary function test. This test is performed by a qualified physician in accordance with 29 CFR 1910.120. This test will include a forced vital capacity (FVC) measurement, which is the maximum lung capacity expired, and the forced expiratory volume (FEV:), which is the total volume pushed out of the lungs in one second.

As determined by the examining physician, any failed test during the medical examination shall disqualify a worker from employment in a restricted area. No employee shall be assigned to work tasks that require the use of respirators or other protective equipment/clothing that may restrict his/her work performance, unless he is medically qualified.

9.2 RESPIRATOR SELECTION

Respiratory protection will be determined by the SHSO based on the following criteria:

- The estimated concentration is in the range requiring respiratory protection, as determined by monitoring information.
- The permissible exposure limit (PEL), threshold limit value (TLV), short-term exposure limit (STEL), ceiling value or maximum permissible concentration (MPC) for the substance may be exceeded.
- The substance is a gas, vapor, mist, dust or fume.
- The substance concentration could be termed immediately dangerous to life or health (IDLH - contact the CIH for consultation and direction).
- The warning properties (i.e., irritation, odor, etc.) of the chemical substances are unacceptable.

Respirator approval is granted by NIOSH via test certification (TC) numbers. Only NIOSH approved equipment will be accepted. All component and replacement parts must also have NIOSH approval. In addition, respirators are approved as a system. No disposable respirators will be used.

9.3 RESPIRATOR TRAINING

The requirements for training are discussed in Section 10.0.

9.4 RESPIRATOR FIT TESTING

Each individual who must wear a respirator shall be required to be clean shaven in the sealing areas of the respirator face piece. Each respirator user shall be qualitatively respirator fit tested at least every six months. Upon donning the respirator device or before entering any restricted work area, each respirator wearer shall be required to perform a negative and positive pressure fit test. Quantitative fit testing will only be performed when it is required under 29 CFR 1910.

9.5 RESPIRATOR ASSIGNMENT

Respirators will be assigned on an individual basis. Respirators should be marked with the employee's name or identification number if the respirator is to be reused by the same employee.

9.6 RESPIRATOR CLEANING, INSPECTION, MAINTENANCE, SANITIZATION, AND STORAGE

Respirators that are used either occasionally or daily shall be cleaned, sanitized, inspected, assembled, and maintained ready for use on a daily basis. Each respirator will be sanitized and stored in a clean and sanitary container. Parts that require inspection include the valves, valve covers, nose piece, straps, eye piece (for full-face respirators), the face piece and its snaps, cylinders, and canisters. The individual responsible for the cleaning, inspecting, sanitizing, maintaining, and storing of respirators will be trained and certified as required in the proper methods and procedures. The specific procedure for the cleaning and maintenance of respirators is shown in Appendix H.

Each respirator user shall store his/her respirator in a clean, sealed plastic bag when not in use, unless it has been determined that the respirator is damaged or is returned at the end of its use. If a respirator becomes damaged, the respirator will be replaced with a clean and sanitized respirator. The respirator wearer shall inspect it for defective parts and leaks.

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9.7 GENERAL CONSIDERATIONS AND LIMITATIONS FOR RESPIRATOR USE

The following criteria will be followed:

- Oxygen Deficient Atmospheres - atmosphere supplying respirators (such as SCBA's or air-line systems with escape bottle) shall be used in atmospheres containing less than 19.5 percent oxygen.

- Immediately Dangerous to Life or Health Atmospheres (IDLH) - atmosphere supplying respirators (such as SCBA's or air-line systems with escape bottle) shall be used in environments that are immediately dangerous to life or health.

- Eye irritation - when working in environments where there is a potential for eye irritation, a full face piece unit shall be used.

- Nuisance dust - any approved filter respirator can be used for nuisance dusts.

- Warning Properties of Substance - chemical cartridge respirators shall not be used for exposures to substances that cannot be easily detected by odor or irritations. For example, cartridge respirators shall not be used to protect against methyl chloride or hydrogen sulfide. The former is odorless and the latter, while foul smelling at low concentrations, will paralyze the olfactory nerve system at high concentrations rendering odor detection unreliable.

- Chemical cartridges will be used only for those substances and the concentrations for which they are certified.

- Chemical cartridges or canisters used for particular substance will be color coded according to 29 CFR §1910.134 Table I-1 as follows:

Substance(s) To Be Protected Against	Color Assigned
Acid gases	White
Organic vapors	Black
Ammonia gas	Green
Carbon monoxide gas	Blue
Acid gases and organic vapors	Yellow
Acid gases, ammonia and organic vapors	Brown
Acid gases, ammonia, carbon monoxide and organic vapors	Red
Other vapors and gases not listed above (pesticides but not for fumigants)	Olive
Radioactive materials (except tritium and noble gases)	Purple
Dusts, fumes and mists (other than radioactive materials)	Orange

10.0 TRAINING REQUIREMENTS

10.1 GENERAL

Personnel working at the site must recognize and understand the potential hazards to worker's health and safety associated with work at remedial sites. Workers involved in remedial action must be thoroughly familiar with programs and procedures contained in the Health and Safety Program. They must be trained to work safely.

All site workers shall be trained to work in compliance with 29 CFR 1910.120; "Hazardous Waste Operations and Emergency Response" and 29 CFR 1910.1200; "Hazard Communication". Each site worker must have a minimum of 40 hours of hazardous waste site training and 3 days of supervised on-the-job training. Employees will not engage field activities until they have been trained to a level commensurate with their job function and responsibilities and with the degree of anticipated hazard.

10.2 GENERAL SITE WORKERS

General laborers, technicians, and other supervised personnel will attend training sessions that apply to their individual jobs and responsibilities, as well as training sessions that provide an overview of the site hazards and the means to control those hazards. Their training will include classroom instruction in the following subject areas, depending on their individual jobs:

- Worker Health and Safety Plan
- Employee rights and responsibilities Safe work practices
- Nature of anticipated hazards
- Handling emergencies and accidents
- Rules and regulations for vehicle use
- Safe use of field equipment
- Handling, storage and transportation of hazardous materials
- Use, care and limitations of personnel protective clothing and equipment
- Safe sampling techniques

10.3 MANAGERS AND SUPERVISORS

On-site managers and supervisors, such as project team leaders, who are responsible for directing others, will receive the same training as the general site workers for whom they are responsible. In addition, they will receive training to enhance their ability to provide guidance and make informed decisions. This additional training will be for a minimum of eight hours and should include:

- Management of hazardous waste site cleanup operations
- Management of site work zones
- How to communicate with the press and the public

The health and safety staff with specific responsibilities for health and safety guidance on-site will be familiar with the training provided to general site workers and their supervisors. They will also receive advanced training in health and safety issues, policies and techniques.

10.4 VISITORS

Visitors to the site (including project managers and other parties, elected and appointed officials, reporters, senior-level managers and other interested parties) must also receive a briefing on safety. These visitors will not be permitted in the restricted work areas unless they have been respirator-trained, fit-tested and medically approved. They, too, are required to have 40 hours of 29 CFR 1910.120 training and present their certificate as proof. Visitors not complying with the above requirements shall not enter the restricted work areas; however, they may observe site conditions from a safe area. The SHSO and PM shall see that visitors to the site are logged in and out, briefed on site conditions and escorted by a designated person at all times on the work site. (Also see Section 13.0, Forbidden Practices.)

10.5 ONGOING HEALTH AND SAFETY TRAINING

Weekly health and safety training for all on-site personnel shall be conducted to reemphasize the salient points of the Health and Safety Program and existing site conditions and to inform team members of changing site conditions. Subcontractors, if they choose, may attend the training sessions/meetings conducted by the contractor or the subcontractor may conduct their own meetings. Health and safety training will be documented on appropriate forms. Contractors conducting their own training sessions will submit proof of attendance to the SHSO.

In addition, all employees will receive eight hours of training annually. This refresher training will be specific for operations on hazardous waste sites.

10.6 RECORD KEEPING

A training record will be maintained in each employee's personnel file to confirm that adequate training for assigned tasks is provided and that training is up-to-date.

10.7 HAZARD COMMUNICATION PROGRAM

The following summary describes the requirements, procedures, training and information applicable to this job-site with regard to hazardous substances. Appendix B contains a Hazard Communication Job-site Checklist and Material Safety Data Sheets (MSDS) for the site constituents.

10.7.1 Warning Labels

The warning label system used for hazardous materials is a nonstandardized system. These labels vary in appearance and content but they should, as a minimum, contain the following information:

- Identity of the hazardous chemical
- Appropriate hazard warnings
- Name and address of the chemical manufacturer, importer or other responsible party

These warning labels should be read by the employee who uses the materials. If you do not understand the messages contained on the label, do not use the material.

10.7.2 Hazardous Materials List

A list of all hazardous materials used on this project will be maintained by the SHSO. This list will be updated frequently. An MSDS for each item on the list will be obtained. The MSDS will be available for viewing or copying at the Site office. Upon reasonable notice, employees may receive copies of the MSDS for the hazardous materials located in their work area.

10.7.3 Employee Information and Training

10.7.3.1 Information to Employees

Each employee working with potentially hazardous chemicals will receive specific training for each operation. The specific

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hazardous chemicals associated with each operation cannot be identified until field operations begin. The materials will not be available until field procurement begins, so the information will not be available until that time. The information will be provided at the site through posting and training. The following format will be used:

Hazardous operations: At this job-site, the following types of operations may use hazardous materials:

Examples:

1. Painting - job-site to list paint and related materials.
2. Acid Washes - job-site to list hazardous materials such as specific acids.

10.7.3.2 Material Safety Data Sheets

Material Safety Data Sheet Training: There are nine sections on a Material Safety Data Sheet. Generic MSDS's have been compiled in Appendix B and are available for personnel to review. Each section contains pertinent information that should be understand before starting to work with a hazardous material. The following paragraphs discuss each section.

Section I - Identifies the chemical and the source, plus emergency telephone numbers.

Section II - Lists the hazardous ingredients by name and the OSHA PEL and the ACGIH TLV.

Section III - Physical Data: This section describes the appearance and odor of a hazardous material, chemical characteristics (e.g., boiling point, vapor density, volatility) and other physical data.

Section IV - Fire and Explosion Data: This section describes the potential of a fire and explosion when using this material and the type of fire extinguishing and fire fighting procedures.

Section V - Health Hazard Data: This section tells the symptoms of over-exposure to the hazardous material. It also gives emergency and first aid procedures that should be used.

Section VI - Reactivity Data: This section tells how stable the product is and lists incompatible materials that should not come in contact with this material.

Section VII - Spill or Leak Procedures: This section addresses the steps to be taken when material is released or spilled. It also describes the waste disposal method.

Section VIII - Special Protection Information: This section tells what respirator, gloves, eye protection, and other equipment is required. Ventilation requirements to prevent accumulation of gases and vapors within the work area are also presented.

Section IX - Special Precautions: This section gives instructions on handling and storage of the hazardous materials and other precautions necessary for employee protection.

10.7.3.3 Employee Protection Training

The Site Health and Safety Officer, or project superintendent will specify what safety and monitoring equipment will be used and will train personnel in its proper use. For each process that uses hazardous materials, the following will be selected according to the properties of the hazardous materials:

- Measures to take to protect personnel when using this hazardous material
- Personal protective equipment to be used
- Monitoring equipment
- Appropriate work practices
- Emergency procedures

11.0 CONTAMINATION CONTROL PROCEDURES

11.1 SITE ACCESS CONTROL

A site access control point shall be established for each restricted area. This access control point shall be maintained to control all access and egress from the restricted area. The following controls shall be measured at this point:

- An access control register shall be maintained in order to record the number of individuals in the area.

- Any personnel desiring to enter or leave the area shall do so through the access control point.

A control point shall be established in close proximity to areas of scheduled on-site work activities. Access to the Exclusion Zones will be restricted through the use of clearly marked signs, hazard tape, or physical barriers such as fences or ropes. Access control points will be established at the periphery of the Exclusion Zones to regulate the flow of personnel and equipment. Appropriate personnel protective clothing and equipment shall be issued at this point based upon specific work activities.

A permanent checkpoint shall be established at the site where personnel remove personnel protective clothing and equipment and are surveyed by the SHSO or his designee for chemical contamination. Neither personnel protective clothing nor equipment shall be taken past this checkpoint.

11.2 DECONTAMINATION

The decontamination process is used to control the spread of impacted materials from the restricted area to non-restricted areas. This is accomplished as personnel and equipment leave the restricted area by physically removing or chemically neutralizing the constituents. Decontamination provided in this instruction covers three categories:

- Personnel protective apparel and equipment

- Vehicles, tools, materials and miscellaneous equipment

- Personnel

Appropriately located decontamination facilities shall be established for each category in the contamination reduction zone located between restricted and non-restricted clean areas. Entry to and exit from the restricted work area shall be limited to these points.

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11.2.1 Personal Protective Apparel and Equipment

All individuals shall be required to don PPE prior to entering the restricted work area. These items will be donned at the decontamination station where previously used PPE is stored. When exiting work areas, individuals shall enter the decontamination station with all PPE on. The SHSO shall establish a minimum of one PPE decontamination station at the site. As a minimum, water, towels, wash pads, and brushes for scrubbing boots will be available. Figures 11-1 through 11-3 describe the order and location of the removal of personal protective clothing and equipment. Figure 11-4 shows the location of the existing Decon Area. The existing Decon Pad will be used for the decontamination of large items. Smaller decon areas will be set up at each Exclusion Zone for the decon of personnel, small items, and the tires of equipment. The location of the smaller decon areas will be determined by the SHSO after evaluating the type of equipment, personnel and duration of the entry into the exclusion zone.

Individuals wearing PPE have the responsibility of decontaminating their own items. Standing in tubs of water, individuals shall scrub the outside of boots, gloves and protective suits. These items will then be rinsed with water. With gloves on, individuals will then remove boots and protective coveralls and hang up or secure them in the storage area. Gloves shall then be removed and stored. Badly soiled or torn PPE shall be deposited in waste cans at the decontamination station to await final disposal. Boots will be decontaminated and left on site during the course of the work. Any wastes generated from decontamination shall be properly disposed. Respirators shall be worn until the individual exits the decontamination station.

Respirators shall be individually fitted and assigned. The wearer shall inspect and clean the respirator with alcohol swipes on a daily basis, or more often as necessary. Any deficiencies shall be reported to the SHSO. When not in use, respirators shall be stored in a clean area, such as the break trailer or individual lockers if available. Respirators shall be turned in weekly to the SHSO or a trained designee for a complete inspection and cleaning. If conditions dictate, respirator maintenance may be performed more frequently.

Personnel involved in decontamination procedures shall wear supplied apparel and equipment as directed by the SHSO. Selection of apparel and equipment shall be based on the degree of hazard presented by the constituents and the working conditions under which exposure may occur.

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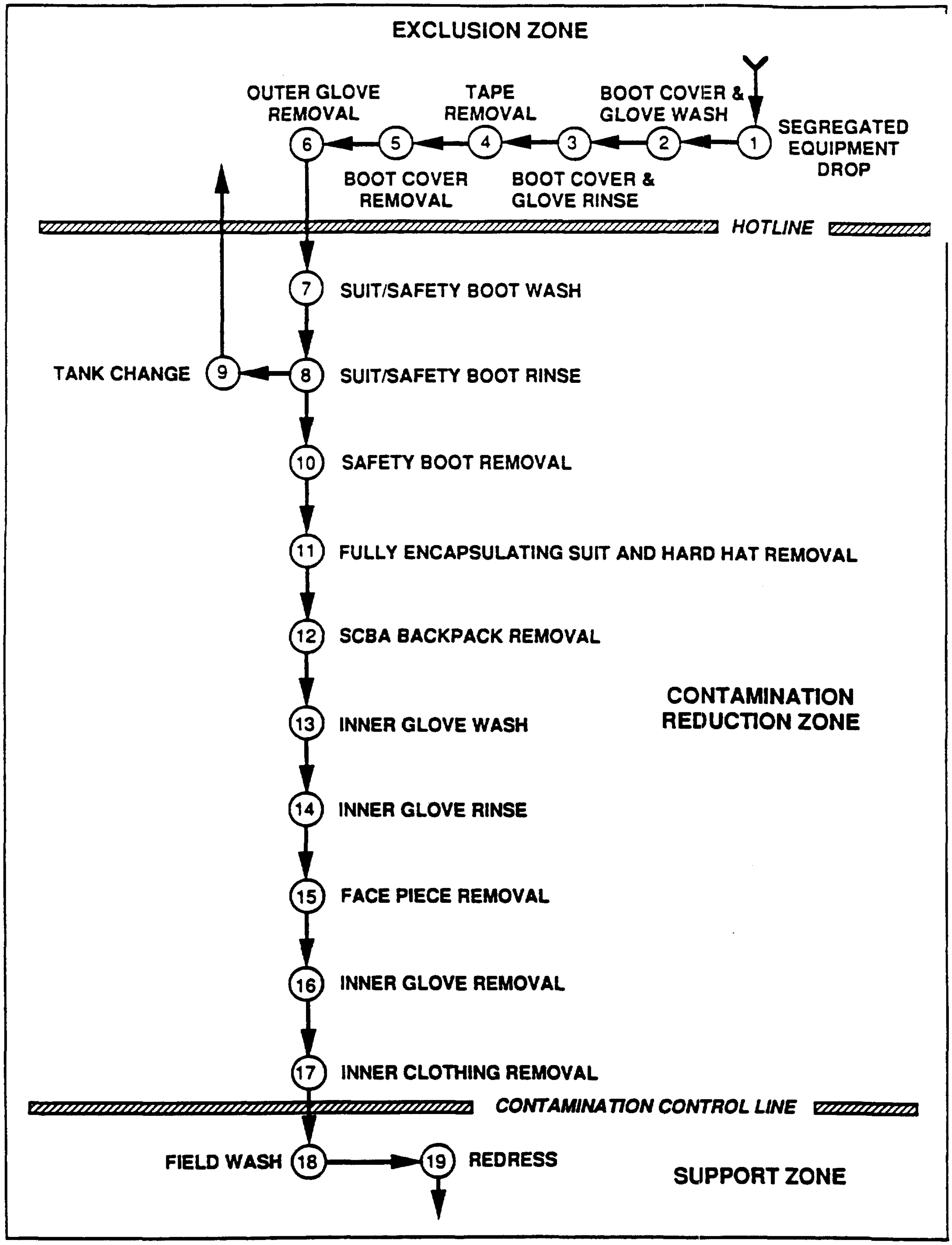

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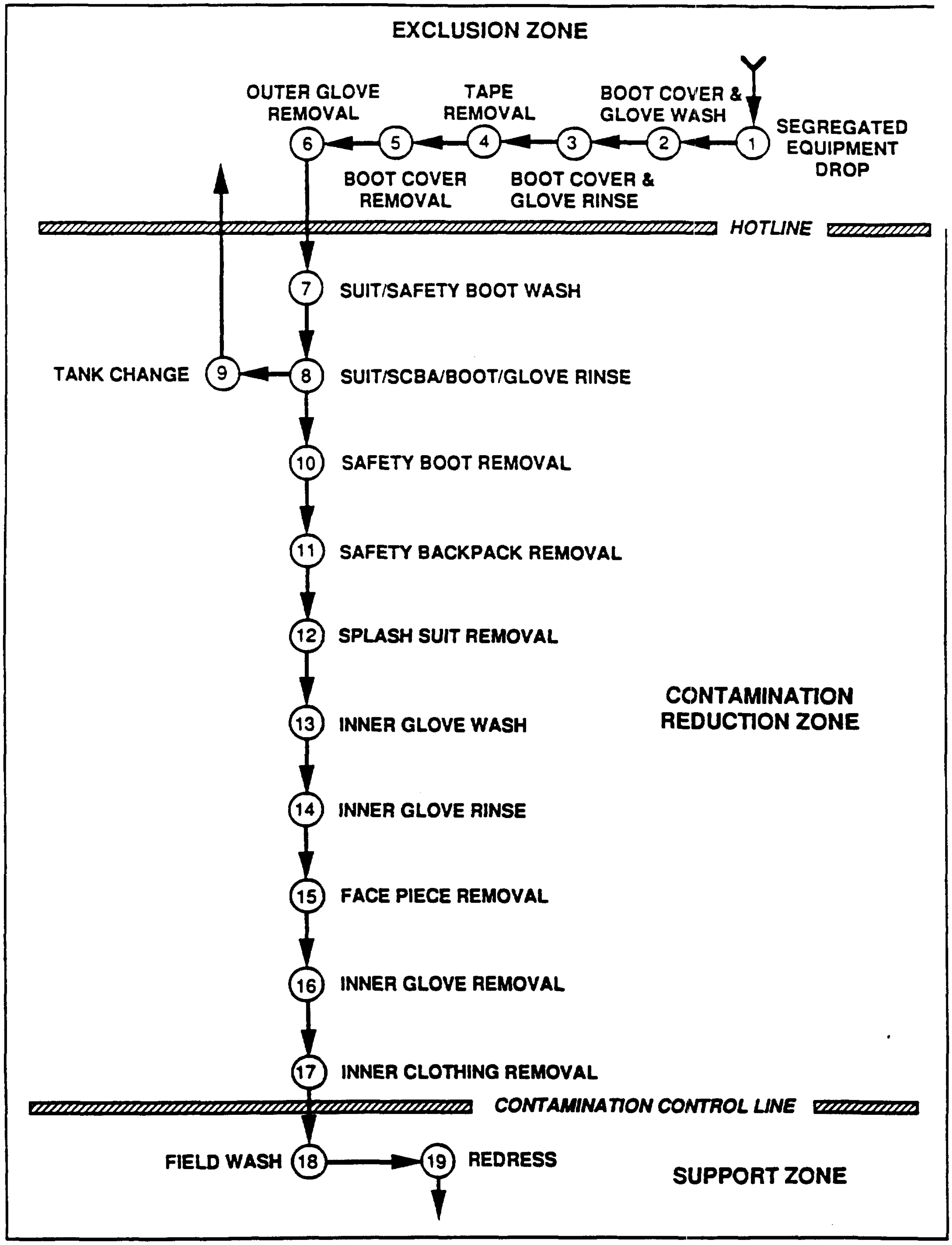
DECONTAMINATION LAYOUT FOR LEVEL A PROTECTION
FIGURE 11-1



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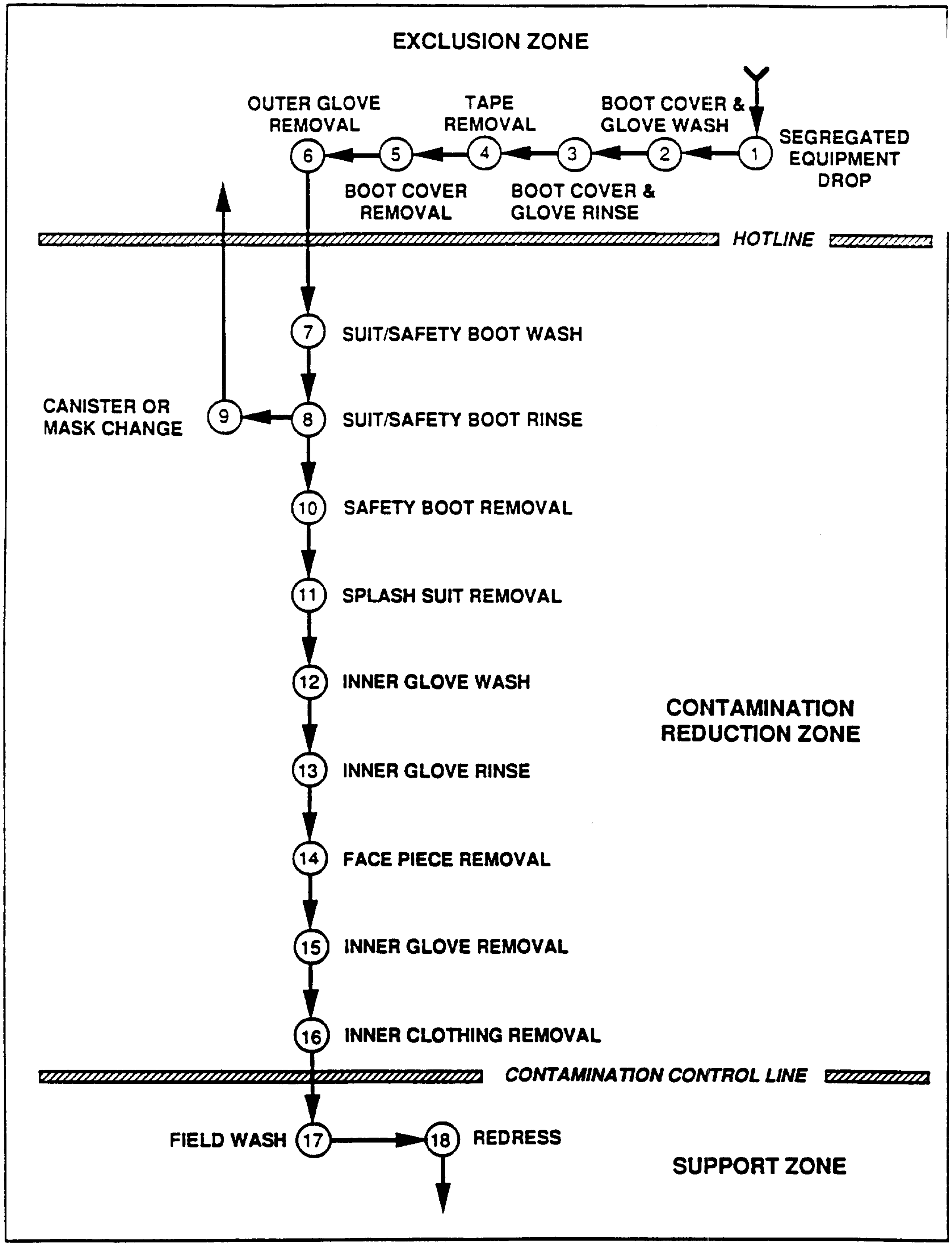
DECONTAMINATION LAYOUT FOR LEVEL B PROTECTION

FIGURE 11-2



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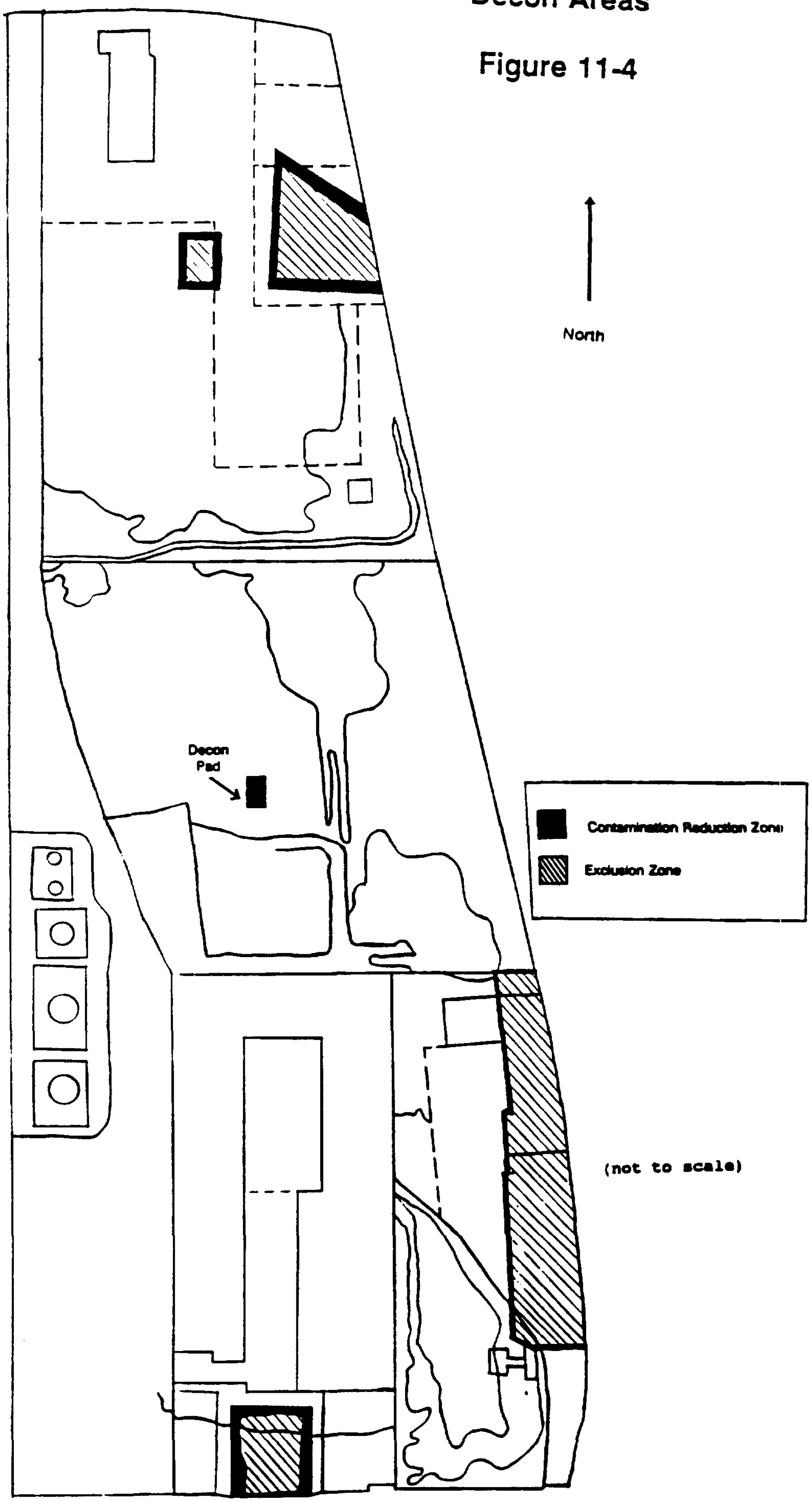
DECONTAMINATION LAYOUT FOR LEVEL C PROTECTION

FIGURE 11-3

Decon Areas

Figure 11-4



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11.2.2 Decontamination of Vehicles, Tools and Work Equipment

Bulldozers, trucks and other heavy equipment are difficult to decontaminate. This is especially true of equipment which has been in prolonged contact with impacted materials. Hand tools are less difficult to clean when wood is not involved. Wood tools shall be used only by protected workers and should be discarded at the conclusion of site activities.

Decontamination may be accomplished by one or more of the following methods:

- Physically remove gross materials (chunks of mud, etc.)
- High pressure water
- Sand blasting
- Hot water with steam, using a steam ejector approved chemical cleaning agents

The process shall be repeated until all visible mud, dirt and grease are removed. Tires, truck beds and other rough surfaced equipment may require vigorous scrubbing with brushes. Special attention shall be given to areas with visible impact. Oil, grease, or other organic substances deposited on surfaces may contain entrapped constituents of concern. Application of a degreaser or detergent solution prior to high pressure water or steam cleaning will usually be necessary. Each piece of equipment shall be pressure sprayed a minimum of three times, or until visually clean as determined by the SHSO. After the final wash, a sample of the final rinse water may be collected and analyzed for site-related constituents as required.

Small impacted items may be washed by hand. They may be brushed, sloshed in a container of water, or sprayed to remove site related materials if the items will not be damaged by exposure to water. Rags or wipes used for cleaning shall be infolded and changed often to avoid the spread of constituents of concern. A final dry wipe should follow where possible. Alcohol or other approved solvents, which dry rapidly and with little residue, may be used to clean items which cannot be safely washed with water.

11.2.3 Personnel Decontamination and Personal Hygiene

Site personnel may be subject to potential skin or eye irritation from various chemicals on-site. An eye wash station and an appropriate method for decontaminating the skin shall be available in areas where eye and skin impact may occur from corrosive or harmful chemicals. Portable eye wash bottles shall be available at

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each location where corrosive chemicals may be present (e.g., washdown facility).

Hoses or other water sources for washing skin will be available at locations where skin contact may occur. Toilet and hand washing facilities shall also be available near the work site, but removed from the impacted areas for sanitary and hygienic purposes.

Proper use of protective equipment should minimize contact with hazardous substances. If an individual should become physically impacted, upon exiting the work area, he should remove protective clothing and wash the affected area of the body with soap and water. After washing affected areas, the individual shall shower or flush the affected area with water to complete the decontamination process. The affected individual shall immediately contact the SHSO, who shall then determine the need for medical evaluation.

Individuals who exit decontamination stations should wash their hands immediately; hands shall be washed before eating. No eating, smoking, drinking, or chewing will be allowed in restricted work areas. Washrooms shall not be entered by individuals wearing PPE. If the SHSO so determines, individuals will be required to shower and change into clean clothes before leaving the job-site at the end of the work day.

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12.0 HAZARDOUS WORK PERMITS

Hazardous Work Permits (HWP) are required for site tasks that present an unusual health and safety problem (e.g., entry into confined spaces, work in high airborne chemical concentrations, and work in flammable atmospheres). A careful review of each potential hazard is to be completed by the SHSO. Normally, the HWP will address the following:

- Medical surveillance
- Personnel exposure monitoring program
- Adherence to As Low As Reasonably Achievable (ALARA) guidelines
- Respiratory protection
- Personal protective equipment and clothing Compliance with rules regarding prohibited activities Hygiene facilities and practices
- Employee information and training

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13.0 FORBIDDEN PRACTICES

The forbidden practices listed below are applicable to all restricted areas. In addition, no worker may engage in any activity for which the consequences of his actions are unclear without the approval of the SHSO. If such activities become necessary in order to complete any phase of the work, a Health and Safety Plan Revision Request or Guide and a HWP properly completed and approved shall be prepared as an addition to this plan.

The following practices shall be strictly forbidden during any work in restricted areas:

- Eating
- Drinking
- Smoking (cigarettes and lighters must be left in the clean area)
- Chewing gum, tobacco, or any other substances (must be left in the clean area)
- Use of facial cosmetics
- Unnecessary sitting or kneeling on impacted surfaces
- Placing equipment on impacted surfaces (when practicable)
- Climbing on or over obstacles
- Starting or maintaining an open flame of any type unless authorized by the SHSO
- Entering the work site with safety equipment that has not been determined to be in proper working condition immediately prior to entry
- Entering the work site, under any circumstances, by any employee, without prior approval
- Contact lenses

In addition to the forbidden practices, the SHSO may impose other prohibitions which he believes may be required for safe operations.

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14.0 AS LOW AS REASONABLY ACHIEVABLE POLICY

The contractor's policy is to maintain exposures to chemical agents at levels that are as low as reasonably achievable (ALARA). ALARA is achieved through proper training of employees, adequate work procedures, adequate engineering controls, good personal hygiene practices and, when required, use of protective equipment. Each individual working in a restricted area is required to adhere to established ALARA rules, regulations, and concepts.

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15.0 THE BUDDY SYSTEM

The buddy system is a health and safety practice in which each individual is concerned with the health and well-being of his/her fellow workers. The buddy system requires the workers to work in pairs when in the Exclusion Zone. The buddy system shall be implemented during all on-site activities and shall be incorporated whenever workers are isolated. Two-way radio communication should be established whenever it is practical.

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16.0 GENERAL SITE SAFETY PROCEDURES

Hazards due to normal site activities can be reduced by using common sense and following safe practices listed below:

- Running and horseplay shall be prohibited.
- All equipment shall be used only by authorized personnel familiar with its use.
- Safety devices on equipment shall be left intact and used as designed.
- Equipment and tools shall be kept clean and in good repair, and used only for their intended purpose.
- Good housekeeping practices shall be followed.
- Use of chemicals shall be limited to authorized personnel familiar with their use and associated hazards.

16.1 HEAVY EQUIPMENT OPERATION

Heavy equipment shall be operated under the following conditions:

- The operation of heavy equipment shall be limited to personnel specifically trained in its operation.
- The operator shall use the safety devices provided with the equipment, including seat belts.
- While in operation, all personnel not directly required in the area shall keep a safe distance from the equipment.
- Personnel directly involved in an activity shall avoid moving into the path of operating equipment, or any portion thereof. Areas blinded from the operator's vision shall be avoided.
- Additional riders shall not be allowed on equipment unless specifically designed for that purpose.

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16.2 MECHANICAL EQUIPMENT OPERATION

Operation of mechanical equipment presents another potential source for physical hazards. Requirements shall include the following:

- Operation shall be conducted by authorized personnel familiar with the machine, its operation and safety provisions.
- Hands, feet, etc., shall be away from all moving parts.
- Maintenance and/or adjustments to machinery shall not be conducted while in operation. Power shall be disconnected prior to maintaining equipment.
- An adequate operating area shall be provided, allowing sufficient clearance and access for operation.
- Good housekeeping practices shall be followed.

16.3 ELECTRICAL HAZARDS

Electrical wiring and apparatus safety procedures shall be conducted in accordance with OSHA's standard 29 CFR Part 1910.137(2). These requirements include, but are not limited to:

- All electrical wiring and equipment shall be of a type listed by UL, or Factory Mutual Engineering Corp. for the specific application.
- All installations shall comply with the National Electrical Safety Code (NESC), or the National Electrical Code (NEC) regulations.
- All work shall be by personnel familiar with code requirements and qualified for the class of work to be performed.
- Live parts of wiring or equipment shall be guarded to protect all persons or objects from harm.
- Electric wire or flexible cord passing through work areas shall be covered or elevated to protect it from damage by foot traffic, vehicles, sharp corners, or pinching.
- Temporary power lines, switch boxes, receptacle boxes, metal cabinets, and enclosures around equipment shall be marked to indicate the maximum operating voltage.

- Patched, oil-soaked, worn or frayed electric cords or cables shall not be used.

- Portable headlamps shall be of the molded composition or other type approved for the purpose. Metal-shell, paper-lined lampholders shall not be used. Handlamps shall be equipped with a handle and a substantial guard over the bulb that is attached to the lampholder or the handle.

- Extension cords or cables shall not be fastened with staples, hung from nails, or suspended by wire.

- All electrical circuits shall be grounded in accordance with the NEC and the NESC unless otherwise noted in the reference manuals.

- Portable and semi-portable electrical tools and equipment shall be grounded by a multi conductor cord having an identified grounding conductor and a multicontact polarized plug-in receptacle.

- Semi-portable equipment, floodlights, and work lights shall be grounded. The protective ground of such equipment should be maintained during moving unless supply circuits are de-energized.

- Tools protected by an approved system of double insulation, or its equivalent, need not be grounded. Double insulated tools shall be distinctly marked and listed by UL or FM.

- Ground fault circuit interrupters (GFCIs) are required in all circuits used for portable electric tools to include block/brick saws. The GFCI shall be calibrated to trip within the threshold values of 5 ma # 1 ma as specified in UL Standard 943. All GFCIs shall be UL listed and installed in accordance with the most recent edition of the National Electric Code. The permanent wiring shall be electrical circuits grounded in accordance with the NEC. GFCIs may be sensitive to some equipment such as concrete vibrators. In these instances, an assured equipment grounding conductor program is acceptable.

- Flexible cord shall be of a type listed by the UL. Flexible cord sets shall contain the number of conductors required for the service plus an equipment ground wire. The cords shall be hard usage or extra hard usage as specified in the NEC. Approved cords may be identified by the word "outdoor" or letters "WA" on the jacket.

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- Bulbs attached by lighting strings and extension cords shall be protected by wire guards or equivalent unless deeply recessed in a reflector.

- Temporary wiring shall be guarded, buried, or isolated by elevation to prevent accidental contact by workers or equipment.

16.4 HOUSEKEEPING

Housekeeping procedures contained herein pertain to uncontaminated trash, debris, and rubbish.

The following housekeeping rules shall apply at the job-site:

- Work areas must be kept clean and free from trash and debris. Trash containers must be located throughout the job-site.

- Excess scrap material and rubbish must be removed from the work areas.

- All surplus materials must be returned to a designated area of the site at the completion of a job.

- Tools and materials must be put in tool boxes or returned to the tool room after use to avoid creation of a hazard for others.

- Oily rags must be placed in approved non-combustible type metal containers.

- Change rooms and shower areas must be kept clean. Accumulations of soiled clothes, paper, towels, etc., are not permitted.

- Toilets, wash-up facilities, and drinking fountains must be kept clean and sanitary; problems must be reported to the supervisor.

- Eating, drinking, use of tobacco products, chewing gum, etc., is permitted only in designated break areas. These activities are not permitted in change or shower areas, toilet facilities, etc.

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16.5 FIRE PREVENTION AND PROTECTION

16.5.1 Fire Prevention

The following rules shall be enforced to prevent fires:

- Smoking shall be permitted in designated areas.
- Flammable and/or combustible liquids must be handled only in approved, properly labeled safety cans.
- Transfer of flammable liquids from one container to another shall be done only when the containers are electrically interconnected (bonded).
- The motors of all equipment being fueled shall be shut off during the fueling operation.
- Flammable/combustible liquids stored in metal drums will be equipped with self-closing safety faucets, vent bung fittings, and drip pans. Such containers shall be stored outside buildings in an area approved by the SHSO. Such metal drums will be properly grounded.

16.5.2 Fire Protection (Also See Appendix E)

The following measures shall be used to protect against fires:

- All construction equipment (cranes, bulldozers, drilling rigs, etc.) will be equipped with a fire extinguisher of 10 ABC units.
- All vehicles will be equipped with a fire extinguisher of 5 ABC units or higher.
- Temporary offices will be equipped with a fire extinguisher of 10 ABC units or higher.
- At lest one portable fire extinguisher of 20 ABC units will be located not less than 15 feet, nor more than 75 feet, from any flammable liquid storage area.
- Storage areas will be kept free of weeds, debris, and other combustible material not necessary to the storage area.
- Fire extinguishers of 10 units or higher will be located in all work areas and their locations be prominently displayed. Fire extinguishers must be so located so that employees are within 50 feet in either direction to reach them.

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16.5.3 <u>Definitions</u>

Combustible liquid -any liquid having a flash point at or above 100°F (60°C) and below 200°F (93.4°C).

Flammable liquid - any liquid having a flash point below 100°F (60°C) and having vapor pressure not exceeding 40 pounds per square inch (absolute) at 100°F.

Flash point - the temperature at which a liquid gives off vapor sufficient to form an ignitable mixture with the air.

Safety can - an approved container of not more than a 5-gallon capacity having a flash-arresting screen, spring-closing lid and spout cover, and so designed that it will safely relieve internal pressure when subjected to fire exposure.

17.0 CONFINED SPACES

A confined or enclosed space is any space with a limited means of exit, and/or which can accumulate harmful or flammable materials or has an oxygen-deficient atmosphere. Confined or enclosed spaces include ventilation or exhaust ducts, sewers, underground utility vaults, tunnels, and open top spaces that are more than four feet in depth, such as pits, tubs, vessel vaults, and sumps.

Employees required to enter a confined space must be instructed by their foreman, general foreman, superintendent, or the Safety Department as to the nature of the hazards involved, necessary safety precautions to be taken, and the emergency and protective equipment required prior to entry.

17.1 PERSONAL PROTECTIVE EQUIPMENT

Necessary rescue and work equipment including life lines, harnesses, belts, stretchers, mobile cranes or hoist must be immediately available at all times. Suitable eye and face protection, and protective clothing must be worn by employees exposed to chemical or physical hazards. Respiratory protection such as a self-contained breathing apparatus, five-minute air capsules, or air-line respirators must be provided when required.

17.2 EMERGENCY LIGHTING

Emergency lighting must be provided at all entrances and exits. When this is not practical, flashlights must be provided. Explosion-proof lighting must be used when employees are working in a potentially explosive atmosphere.

17.3 ENVIRONMENTAL TESTING

In areas where explosive or toxic air constituents or deficiencies of oxygen are suspected, the atmosphere must be tested by the Safety Department or a qualified person to ensure that explosive or toxic limits are not exceeded, and that the oxygen concentration is not below 19.5 percent. This atmospheric monitoring must be done within one hour before employees enter the area, unless a permanent monitor is installed, in which case the area must be monitored once per shift.

During inert gas welding or other work that could create an oxygen deficient atmosphere, portable or fixed oxygen analyzers with visual or audible alarms must be provided in the confined space.

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Any area suspected of being oxygen deficient, or exceeding toxic or explosion limits must take the following precautions:

- Station someone at the entry to stop others from entering the area.
- Promptly report the danger to the Safety Department.
- Post appropriate warnings that state, "Area Unsafe - Do Not Enter."
- Ventilate or exhaust with fresh air for 30 minutes.
- Recheck before entry.
- Determine and eliminate the problem.

The Safety Department must coordinate the maintenance and calibration of all monitoring equipment and arrange for adequate sampling for toxic gases as necessary.

17.4 VENTILATION AND/OR EXHAUST

Ventilation and/or exhaust must be maintained in all confined or enclosed areas to avoid concentrations of toxic and hazardous gases and dusts that exceed prescribed limits.

The person in charge is responsible for assuring proper ventilation and exhaust before work starts. The Safety Department is responsible for making appropriate tests and advising the person in charge when the breathing air meets OSHA requirements or when the confined space is safe for entry.

In areas where adequate ventilation and/or exhaust cannot be provided, personnel must wear appropriate respiratory protection and possibly other emergency protective equipment. These unique work operations will be monitored by the Safety Department.

17.5 RECORD KEEPING REQUIREMENTS

A hazardous work permit is prepared and signed by the person in charge before anyone enters the confined space. The Safety Department then checks that all requirements of this procedure have been met and approves the permit. The permit consists of a checklist that includes exits, emergency lighting, toxic gases, flammable gases, oxygen monitors, fire protection, breathing apparatus, and emergency equipment.

A log of all atmospheric sampling in confined or enclosed spaces is maintained by the Safety Department. The log includes the date, time, location, O° and LEL reading, permit number, and the name of the individual who performed the survey. 009571

Records of all confined-space training is maintained by the Safety Department. This topic must also be covered in new-hire safety orientation and when entering special conditions or unusually confined spaces.

17.6 FIRE PROTECTION

The following precautions must be taken in confined or enclosed spaces at all times:

- Access ladders, floors, and components that require protective wrapping must be covered with flame retardant material.
- Flammable liquids (i.e., acetone, alcohol, etc.) must be stored in Underwriters Laboratory or Factory Mutual approved flammable liquid containers or dispensers; the amount of flammable liquids must not exceed the amount necessary to perform the work each day.
- Proper fire extinguishers must be immediately available.
- Cylinders containing oxygen, acetylene, or other fuel gases must not be taken into confined or enclosed spaces.
- All rags, brushes, wipes, gloves, etc., must be stored in metal containers with lids when not in use.
- Current pre-fire plans (evacuation, rescue, equipment, notification, etc.) must be in effect. The Safety Department will maintain current fire plans for the site fire brigade.
- A person must be posted to monitor for fires during all welding, burning, and heating operations.
- Flammable gas equipment, hoses, etc., must be free of defects. They must be inspected by the user before each use.
- Combustibles that would be exposed to flames or sparks must be removed or adequately covered to prevent ignition.
- In enclosed spaces the gas supply to the torch valves must be shut whenever the torch is not used or left unattended,

such as during the lunch period. During a shift change and overnight, the torch and hose must be removed from the confined space and disconnected at the bottom or manifold. Open end fuel gas and oxygen hoses must be immediately removed when they are disconnected from the torch or other gas-consuming device. All gas manifold isolation valves must be closed at the end of each shift or when the job duty is completed.

17.7 COMMUNICATIONS

Communications must be maintained with all personnel in enclosed or confined spaces, using one or more of the following methods:

- Someone outside the confined space who can see the workers
- Someone outside the confined space who can hear the workers
- Telephone - via hard wire
- Two-way radio

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APPENDIX A

MEDICAL SURVEILLANCE PROGRAM

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MEDICAL SURVEILLANCE PROGRAM

1.0 PURPOSE

The purpose of this instruction is to provide criteria for administration of the Project Medical Surveillance Program.

2.0 SCOPE

This procedure applies to all Project personnel who may be exposed to impacted substances as a result of their work assignments.

3.0 DEFINITIONS

Exposure is that condition which may occur when an employee is not adequately protected from the harmful effects of constituent(s) of concern. Such substances may cause harm by gaining entry to the body by inhalation, ingestion, skin absorption or direct contact.

4.0 PROCEDURES

A medical surveillance program will be conducted for operations in accordance with the following procedures.

The examining or consulting physician will be responsible for determining when an employee may work in a Controlled Area, wear negative pressure and/or other respiratory protective equipment (e.g., full face canister respirator, self-contained breathing apparatus, etc.), and/or wear stressful protective clothing (e.g., butyl rubber suits). The examining physician will be required to evaluate the individual based on the criteria specified in Attachment 1. Deviation from this criteria may be done only in consultation with the Site Health and Safety Officer (SHSO), the Health and Safety Manager and a Certified Industrial Hygienist.

4.1 DESIGNATION OF CONTROLLED ACCESS AREAS

Controlled Access Areas shall be designated on site. contractor personnel shall not be allowed to work in a Controlled Access Area until the SHSO has received a positive declaration of the employee's physical fitness from the examining physician.

4.2 BASELINE HEALTH ASSESSMENT

All contractor personnel assigned to work in Controlled Access Areas shall undergo a Baseline Health Assessment (BHA) unless the individual already participates in an OSHA 29 CFR 1910.120(f) medical examination program (within the past 12 months), prior to commencement or continuation of work. The BHA shall include, as a minimum, the regime presented in Attachment 1.

1.4.3 PERIODIC HEALTH ASSESSMENT

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All individuals involved in the medical surveillance program shall undergo Periodic Health Assessments (PHA) annually, upon cessation of project work, and/or as directed by the SHSO. For short duration (i.e., less than or equal to six months) projects, the total BHA should not be repeated upon cessation. Specific exams that will be repeated include the physician's evaluation, pulmonary function, and urinary phenol. Additional tests will be based on the physician's determination, air monitoring results, and exposure potential assessments. For projects which last longer than six months, the total BHA will be repeated upon cessation. The regime for the PHA shall include, as a minimum, the BHA criteria, and may include such additional criteria as deemed necessary by the SHSO and the examining or consulting physician. Additional requirements shall be based on documented Potential Exposures.

4.4 SUPPLEMENTAL HEALTH ASSESSMENT

Individuals who have sustained a significant body burden or exhibit symptoms of an actual exposure shall be provided a Supplemental Health Assessment (SHA). The SHA will include all tests determined necessary by the examining physician in consultation with the SHSO, an Industrial Hygienist, and the Health and Safety Manager. The initial SHA shall be conducted as soon after the exposure or demonstration of symptoms as practical. The need for a SHA shall not supplant emergency treatment if symptoms are debilitating.

4.5 FAILURE TO MEET MEDICAL CRITERIA

The examining or consulting physician shall advise the SHSO and contractor through the Physician's Statement, Attachment 5, of any employee who fails to meet the criteria for any health assessment defined in Sections 4.2, 4.3 or 4.4 of this procedure. The SHSO shall notify the contractor employee and his/her Department Supervisor of the failure to meet such criteria and recommend that the employee see his/her family physician.

The contractor shall notify its employees of failure to meet medical criteria.

Any employee who fails a medical health assessment shall be prohibited from working in Controlled Access Areas. The SHSO shall submit to the Project Manager and Site Superintendent a list of all personnel who are medically qualified to wear respiratory protective equipment and to enter Controlled Access Areas. This list shall be updated by the SHSO when there are changes in personnel medical qualifications. The Site Superintendent is responsible for ensuring that only medically qualified personnel are permitted in Controlled Access Areas.

Any person who has sustained a significant body burden from an actual exposure shall be removed from the Controlled Access Area until the SHSO and/or the examining or consulting physician

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determines the employee can continue to work in the contaminated environment.

4.6 FORMS TO BE COMPLETED PRIOR TO EXAMINATION

The following forms shall be completed by the individual prior to the physical examination:

4.6.1 Medical Questionnaire

The individual shall complete the Medical Questionnaire (Attachment 2) which includes medical, occupational, and family history. The completed forms shall be presented to the examining physician at or before the scheduled time of the examination.

4.6.2 Privacy Statement

The individual shall be given a copy of the Privacy Statement (Attachment 3). The individual shall be required to sign the acknowledgment in the Privacy Statement. The original of the signed Privacy Statement shall be forwarded to the SHSO, with a copy provided to the individual.

4.6.3 Medical Records Release

The individual shall be required to complete the Medical Records Release (Attachment 4). The completed form shall be presented to the examining physician at or before the scheduled time of the examination.

4.7 FORMS TO BE COMPLETED BY THE PHYSICIAN

The examining physician will be required to complete the Physician's Statement.

The Site Superintendent shall immediately forward the confidential document to the SHSO.

The SHSO will supply the Site Superintendent an updated list of personnel medically qualified to work in Controlled Areas.

4.8 RECORDS

4.8.1 Contractor Employee

The examining or consulting physician shall maintain a copy of records of baseline and periodic assessments for the duration of each employee's employment with the contractor. The completed Physician's Statement will be maintained by the SHSO and the Health and Safety Manager. Upon termination of the employee's employment, including retirement or death, the medical records shall be maintained by the Health and Safety Manager, as required by

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applicable federal and state regulations, in a manner that will ensure ready access as needed by the medical monitoring programs of the EPA or the NRC.

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5.0 RESPONSIBILITIES

The Site Health and Safety Officer shall ensure that each worker who may be work in a Controlled Area receives an appropriate medical examination.

The Site Superintendent shall ensure that each worker has any required medical examination prior to work in a Controlled Area.

The examining physician shall provide a statement indicating the worker's medical qualification for working Controlled Areas.

6.0 REFERENCES

EPA, "Occupational Health and Safety Manual," Chapter 9, August 1980.

EPA, "Safety Manual for Hazardous Waste Site Investigations," Appendix B, September 1979.

NRC 10 CFR 20.130, "Exposure of Individuals to Concentrations of Radioactive Materials in Air in Restricted Areas"

NRC, Regulatory Guide 8.6, "Occupational Radiation Exposure Records Systems"

NRC, Regulatory Guide 8.9, "Acceptable Concepts, Models, Equations and Assumptions for a Bioassay Program.

NRC, Regulatory Guide 8.11, "Application of Bioassay for Uranium"

NRC, Regulatory Guide 8.22, "Bioassay at Uranium Mills"

NRC, Regulatory Guide 8.26, " Applications of Bioassay for Fission and Activation Products"

OSHA 29 CFR 1904, "Recording and Reporting Occupational Injuries and Illnesses"

OSHA 29 CFR 1910, "Safety and Health Standards"

OSHA 29 CFR 1926, "Safety and Health Regulations for Construction"

7.0 ATTACHMENTS

Attachment 1, Criteria for the Baseline Health Assessment.

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Attachment 2, Medical Questionnaire.

Attachment 3, Privacy Statement.

Attachment 4, Medical Records Release.

Attachment 5, Physician's Statement.

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HEALTH ASSESSMENT CRITERIA

One intended result from each health assessment is to establish whether or not, in the physician's medical judgement, the examined individual is in good health with no medical condition that might put the individual at increased risk from work in a Controlled Area or from respirator use. This is documented on the physician's statement form (Attachment 5). To meet this intent, each health assessment must include the elements described below. The medical examination should be supplemented by procedures and special tests only as warranted by the health status of the individual and likely or documented exposures to specific hazards or stresses.

For each health assessment subsequent to the baseline health assessment, the examining physician pays particular attention to changes in the individual's health status since the baseline assessment, in order to evaluate the need for additional surveillance or treatment for medical conditions potentially arising from site work.

1. QUESTIONNAIRE REVIEW AND SCREENING PHYSICAL EXAM

   The examining physician reviews the completed medical questionnaire (Attachment 4); discusses it, as necessary, with the employee to confirm that relevant information is identified; and conducts a screening physical examination.

2. BASIC BLOOD AND URINE LABORATORY TESTS

   BLOOD TESTS. Each assessment includes a basic panel of blood counts and chemistries to evaluate blood-forming, kidney, liver, endocrine, and metabolic functions. The following blood tests are the minimum desirable:

   - White blood cell count, differential cell count, and platelet estimate
   - Hemoglobin and/or hematocrit
   - Albumin, globulin, and total protein
   - Total bilirubin
   - Serum glutamic oxalacetic transaminase (SGOT)
   - Serum glutamic pyruvic transaminase (SGPT)
   - Lactic dehydrogenase (LDH)
   - Inorganic phosphatase
   - Calcium
   - Phosphorous
   - Uric Acid
   - Creatinine
   - Urea nitrogen
   - Cholesterol
   - Glucose

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URINE TESTS. Each assessment includes the following urinanalysis:

- Specific gravity
- pH
- Microscopic examination
- Protein
- Acetone
- Glucose
- Albumin

3. PULMONARY FUNCTION TESTS

The examining physician administers pulmonary function tests on a spirometer, measuring forced vital capacity (FVC, the maximum lung capacity expired) and forced expired volume (FEV_1, the total volume pushed out of the lungs in one second), comparing these values to the Spirometry Prediction Tables for Normal Males and Females (29 CFR 1910 [Ref. 1], 1910.1043).

4. RESPIRATOR USE EVALUATION

The physician closely evaluates the skin, cardiac, and pulmonary systems of respirator users, and carefully examines histories or symptoms of allergy and any personality or psychological factors which may affect an individual's ability to use a respirator effectively. Since specific health requirements for respirator users are not available, the physician must judge an employee's fitness for respirator use on the basis of clinical findings and projected respirator demands.

5. VISION SCREENING

The physician administers screening tests for visual acuity, depth and color perception.

6. AUDIOMETRIC TESTING

The physician or technician administers pure tone audiometric tests (air conduction) for each ear. Minimum test frequencies are 500, 1,000, 2,000, 3,000, 4,000 and 6,00 Hz.

7. OTHER TESTS

X-RAY. Chest x-rays are not routinely performed as part of the health assessment. X-rays are obtained only when clinically indicated by other testing procedures, such as pulmonary function test. A baseline chest x-ray may be performed if it is recommended by the examining physician for the medical evaluation of the employee. However, no baseline chest x-ray is obtained if the employee has had one within the past three years; that record should be obtained from the former physician, radiologist, or hospital. X-rays should be standard 14 x 17 inch posterior-anterior (P-A) exposures. All films are read or reviewed by a board-certified radiologist or other competent medical specialist.

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ELECTROCARDIOGRAM. An electrocardiogram of the standard 12-lead resisting type is included in the baseline examination, and should be interpreted by an internist or cardiologist. Subsequent periodic electrocardiograms are obtained when recommended by the examining physician, and not as a routine measure. The examining physician should consider exercise electrocardiography (stress test) for employees over 35 or for those displaying obvious risk factors for coronary artery disease (obesity, heavy smokers, etc.). The frequency of exercise electrocardiograms is based upon the examining physician's recommendations. The examining physician should be aware that expected work operations include the use of chemical protective clothing and respirators that may increase heat or other physiological stress impacts upon the individual.

SPECIAL TESTS. Employees may need special tests in addition to those outlined above. Criteria for such tests are established in conjunction with known or suspected exposure hazards. Examples of special tests for specific substance hazards are as follows:

Substance	Recommended Special Tests
Inorganic arsenic	Sputum cytology, urinary arsenic
Benzene	Reticulocyte count
Cadmium	Urinary analysis
Mercury	Urinary mercury, blood mercury, liver and kidney function, signs of gingivitis and tremors
Inorganic lead	Blood lead, peripheral blood smear morphology

The examining physician determines the need for special tests after reviewing an employee's medical questionnaire and consulting with the project's industrial hygiene personnel. The physician may, in addition, recommend one or more of the following non-routine tests:

- VDRL or other serologic test for syphilis
- Serum specimen for freezing and storage
- Female cervical cytology test (Pap test)
- Serum triglycerides
- Serum sodium, potassium, and total chlorides
- Gamma glutamyl transpeptidase (GGTP)
- Carcino-embryonic antigen
- Stress electrocardiogram

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MEDICAL QUESTIONNAIRE

For Medical Use Only

Date ______________________________

Name ____
(Last) (First) (Middle)

Bechtel Division ____

Location ____

Regular Workplace ____
(Building and Room Number)

Job Title ___________________________ Years in Present Job _____

Male [ ]   Female [ ]

Age _____   Date of Birth _______________________

(Month, Day, Year)

Marital Status: Married [ ] Single [ ] Separated [ ]
Divorced [ ] Widowed [ ]

OCCUPATIONAL HISTORY

Indicate any job-related illnesses or injuries you have experienced.

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In your work are you now or have you been exposed to any of the following agents?

Exposure	Present	Past	Comments
Inorganic fluorides	[ ]	[ ]	
Lead	[ ]	[ ]	
Benzene	[ ]	[ ]	
Coke oven emissions	[ ]	[ ]	
Inorganic arsenic	[ ]	[ ]	
Methyl chloride	[ ]	[ ]	
Vinyl chloride	[ ]	[ ]	
Toluene diisocyanate	[ ]	[ ]	
Excessive noise	[ ]	[ ]	
Nitrogen oxides	[ ]	[ ]	
Crystalline silica	[ ]	[ ]	
Nitric acid	[ ]	[ ]	
Ammonia	[ ]	[ ]	
Beryllium	[ ]	[ ]	
Phosgene	[ ]	[ ]	
Allyl chloride	[ ]	[ ]	
Asbestos	[ ]	[ ]	
Suspect or know carcinogens	[ ]	[ ]	
Pesticides	[ ]	[ ]	
Bacteria or viruses	[ ]	[ ]	
Primate animals	[ ]	[ ]	
Vibrating tools	[ ]	[ ]	
Radiation (which isotopes			

if known) [ ] [ ]

List any other substances that you handle in your work. Star those that particularly concern you from a health standpoint.

Do you have any suggestions to reduce potential exposures?

Indicate any symptoms that you have experienced that might be due to exposure at work and indicate the suspected cause.

MEDICAL HISTORY

Please answer the following questions by checking the applicable blocks:

Yes [ ] No [ ] Have you ever been hospitalized? If yes, give details and dates:

Yes [ ] No [ ] Have you ever had an operation(s)? If yes, give details and dates:

Yes [ ] No [ ] Have you ever been a resident outside the United States? If yes, please list location(s) and date(s):

Are you now taking or have you taken any of the following within the past month?

[ ] Antacids
[ ] Antibiotics
[ ] Anticoagulant (blood thinner)
[ ] Antidepressants
[ ] Antihistamines
[ ] Appetite depressants
[ ] Aspirin
[ ] Benzedrine
[ ] Birth control pills
[ ] Blood pressure medication
[ ] Codeine
[ ] Cortisone or steroids
[ ] Dexedrine
[ ] Digitalis
[ ] Diuretic
[ ] Hormones
[ ] Insulin or oral anti-diabetic drug
[ ] Laxatives
[ ] Morphine
[ ] Sleeping pills
[ ] Sulfa preparations
[ ] Thyroid
[ ] Tranquilizers
[ ] Vitamins

List any drugs you take regularly:

____

____

Yes [ ] No [ ] Have you been on any special diet(s) in the past year? If yes, described type:______________________

____

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Are you allergic to any of the following:

[ ] Pollens
[ ] House dust
[ ] Animal dander, feathers, or fur
[ ] Drugs
[ ] Vaccines
[ ] Serum
[ ] Metal, jewelry
[ ] Foods
[ ] Sunlight or cold

If yes, please list or provide details:

____

____

IMMUNIZATION, VACCINES ANTITOXINS

Check if you have received any of the following and give approximate date(s) when last received, if known:

[ ] Tetanus ____
[ ] Poliomyelitis ____
[ ] Influenza ____
[ ] Typhoid ____
[ ] Diphtheria ____
[ ] Rabies ____
[ ] Rubella (German measles) _____________________________
[ ] Measles (Rubella or red measles) _____________________
[ ] BCG ____
[ ] Yellow fever ____
[ ] Small pox ____
[ ] RhoGAM (Rh immune globulin) __________________________
[ ] Immune serum globulin for hepatitis __________________
[ ] Others (please list) _________________________________

____

[ ] Mantoux, patch test, or other skin test for tuberculosis
Give date and result of last test, if known:

Date ____________________ Result: Positive [ ] Negative [ ]

Yes [ ] No [ ] Do you drink alcoholic beverages?

If yes, please answer the following:

Yes [ ] No [ ] Do you average drinking more than one bottle of beer per day?

Yes [ ] No [ ] Do you drink more than a bottle of wine per week?

Yes [ ] No [ ] Do you drink more than a fifth of liquor per week?

Yes [ ] No [ ] Do you smoke?

If yes, please answer the following:

How long have you smoked? ____________ Years
How many of the following do you smoke per day:
Cigarettes ____________________________________
"Pipes" of tobacco ____________________________
Cigars ____

If no, are you a former smoker? Yes [ ] No [ ]

If yes, how long ago did you quit? ________________ Years
How many years did you smoke before quitting? _____ Years
How much were you smoking when you quit; i.e., number of cigarettes, "pipes", or cigars smoked per day?
____

FEMALES ONLY:

Number of pregnancies ______________________________________
Number of living children __________________________________
Number of miscarriages _____________________________________
Date of last Pap test ______________________________________
Date of last period ____

Yes [ ] No [ ] Have you had any unusual discharge or bleeding in the past three months?

Yes [ ] No [ ] Have you reached menopause?

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Have you had or do you now have any of the following illnesses or conditions? If so, please check the appropriate block(s):

[ ] Abnormal Bleeding
[ ] AIDS
[ ] Allergies
[ ] Anemia
[ ] Arthritis
[ ] Asthma
[ ] Back pain
[ ] Blood in urine, sputum, or stool
[ ] Blood pressure, high
[ ] Blood pressure, low
[ ] Bowel problems
[ ] Cancer
[ ] Chest pain
[ ] Chronic cough
[ ] Cirrhosis of the liver
[ ] Cold or painful fingers
[ ] Constipation
[ ] Dental or gum problems
[ ] Depression or excessive worry
[ ] Dermatitis
[ ] Diabetes
[ ] Diarrhea
[ ] Difficulty in sleeping
[ ] Dizziness
[ ] Ear or hearing problems
[ ] Endema (foot or leg swelling)
[ ] Epilepsy
[ ] Erysipelas (skin inflammation)
[ ] Eye trouble (other than glasses)
[ ] Fainting spells or unconsciousness
[ ] Fever
[ ] Frequent or severe headaches
[ ] Frequent indigestion
[ ] Gallbladder, stones
[ ] Glaucoma
[ ] Gout
[ ] Hay fever
[ ] Heart attack, trouble, murmur
[ ] Hemorrhoids (piles)
[ ] Hepatitis
[ ] Hernia or rupture
[ ] Herpes
[ ] Hives
[ ] Hot flashes
[ ] Jaundice
[ ] Joint pains
[ ] Kidney problems, stones
[ ] Leg cramps
[ ] Leukemia
[ ] Liver problems
[ ] Loss of memory
[ ] Lung or breathing difficulty
[ ] Malaria
[ ] Menopause
[ ] Mumps
[ ] Muscle aches or pains
[ ] Nephritis (Bright's disease)
[ ] Nervous breakdown
[ ] Nervousness
[ ] Neuritis
[ ] Paralysis of any type
[ ] Pneumonia
[ ] Polio
[ ] Rheumatic fever
[ ] Scarlet fever
[ ] Sickle cell disease or trait
[ ] Skin disease
[ ] Stomach pain
[ ] Stroke
[ ] Swollen glands
[ ] Swollen joints
[ ] Thyroid gland problem
[ ] Tremor of hands or head
[ ] Tuberculosis
[ ] Tumors or cysts
[ ] Ulcer (stomach or duodenal)
[ ] Unexpected weight gain
[ ] Unexpected weight loss
[ ] Unusual weakness
[ ] Venereal disease

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FAMILY HISTORY

Indicate any blood relatives who have or have had any of the following:

	Relationship to Me				
Disease	Mother	Father	Grand-Parent	Brother or Sister	Children
Anemia	[ ]	[ ]	[ ]	[ ]	[ ]
Allergy (asthma, eczema, hay fever)	[ ]	[ ]	[ ]	[ ]	[ ]
Alcoholism	[ ]	[ ]	[ ]	[ ]	[ ]
Arthritis	[ ]	[ ]	[ ]	[ ]	[ ]
Bleeding disorders	[ ]	[ ]	[ ]	[ ]	[ ]
Cancer	[ ]	[ ]	[ ]	[ ]	[ ]
Congenital malformations	[ ]	[ ]	[ ]	[ ]	[ ]
Diabetes	[ ]	[ ]	[ ]	[ ]	[ ]
Emphysema	[ ]	[ ]	[ ]	[ ]	[ ]
Epilepsy	[ ]	[ ]	[ ]	[ ]	[ ]
Glaucoma	[ ]	[ ]	[ ]	[ ]	[ ]
Gout [ ]	[ ]	[ ]	[ ]	[ ]	
Heart attack	[ ]	[ ]	[ ]	[ ]	[ ]
High blood pressure	[ ]	[ ]	[ ]	[ ]	[ ]
Kidney disease	[ ]	[ ]	[ ]	[ ]	[ ]
Kidney stones	[ ]	[ ]	[ ]	[ ]	[ ]
Mental retardation	[ ]	[ ]	[ ]	[ ]	[ ]
Sickle cell disease	[ ]	[ ]	[ ]	[ ]	[ ]
Stomach ulcers	[ ]	[ ]	[ ]	[ ]	[ ]
Stroke	[ ]	[ ]	[ ]	[ ]	[ ]
Tuberculosis	[ ]	[ ]	[ ]	[ ]	[ ]

If either of your parents is dead, list age and cause of death, if known:

Mother died age _____ of ______________________________

Father died age _____ of ______________________________

Yes [ ] No [ ] Are you aware of any diseases or illnesses that run in your family?

If yes, please list:

____

____

When you have finished this Medical Questionnaire, hand it directly to the doctor or nurse, or if mailed, make envelope "To Be Opened Only by Medical Personnel."

PRIVACY STATEMENT: MEDICAL SURVEILLANCE PROCEDURE AND RECORDS

A. Authority under which the information is requested:

Privacy Act of 1974 (Public Law 93-579)

B. Uses to be made of the information:

The purpose of requesting personal information is to enable the Examining Physician and other health personnel to provide an occupational health program directed primarily to protecting you and your fellow workers from potential hazards in your work environment and the reduction of these hazards. The records will document your health stature, changes in physical conditions through the years, and provide an account of any care rendered, advice given, and consultations that are recommended.

This information may be used to determine unusual susceptibility to illness or injury from exposures in your work environment, to determine suitability for assignments, to permit medical surveillance for potential harmful effects of toxicants used in your work, and to provide medical treatment and advice. It may be used to plan, implement and evaluate occupational and preventative health programs, conduct epidemiologic research, teach, and compile statistical data. It may be used to adjudicate claims and determine benefits, and report medical conditions required by law to Federal, State, and local agencies. It may be used for other purposes including litigation.

C. Rules of confidentiality;

The information contained in these files will be open to review and usage by other Examining Physicians and/or duly authorized assistants except as noted below.

Information to be utilized for research, teaching, statistical, or epidemiologic purposes will have all identifying day obliterated and made unrecognizable as to the identity of an individual.

The records will be in the local custody of the Examining Physician and will be maintained in a locked filing cabinet. Access will be limited to the custodian and/or duly appointed health assistants. A copy of these records may be maintained in the office of the Health and Safety Manager. These will be maintained in locked cabinets with access limited to the Manager or to authorized assistants.

Upon death, retirement, resignation, or other termination of service, the records will be forwarded to Health and Safety

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Manager for inclusion with the Official Personnel Records and the custody thereof will fall to the custodian of such records.

Medical information about an applicant shall not be made available to the public.

Medical information about an employee shall be disclosed to the employee, or a representative designated in writing, except that medical information concerning a mental or other condition of such a nature that a prudent physician would hesitate to inform a person suffering from it of its exact nature and probable outcome may be disclosed only to a licensed physician designated in writing for that purpose by the individual or his designated representative. The determination on whether information falls into the purview above will rest with the custodian.

The employee may request release of records or information, and/or designate a representative, in a letter directed to the custodian of the records. The request will give the full name of the representative and indicate the records to be released.

D. Disclosure of information by participants:

Disclosure of the required information is entirely voluntary except for employees for whom disclosure is a condition of employment or where a medical certificate is required before assignment to positions which involve: (a) operations of motor vehicles; (b) exceptional stress; (c) food handling; (d) direct physical contact with people - for example, nurses and physical therapists; (e) work above ground level or around hazardous power-driven machinery; or, (f) strenuous exertion or hazardous duty or arduous physical requirements - for example, aircraft pilots and flight crew members, underwater divers, and firefighters. Pilots, flight crew members, and divers will not be certified or recertified if the information is not furnished. Other persons may decline to participate in or withdraw from the Medical Surveillance Program at any time without prejudice to themselves or to their jobs. If the information is not furnished, however, a complete occupational health evaluation cannot be done and will not be attempted; optimum advice and care may therefore not be possible. Delay in certain benefits may result from the lack of available information about an employee.

E. Privacy Statement Acknowledgment

I have received a copy of this statement, which I may retain, and I understand that I may receive additional copies of this statement upon request. I understand that a copy of this statement will be placed in my health records as evidence of this notification.

(Type or print name)

(Company Name)

(Signature) (Date)

EMPLOYEES: COMPLETE THIS FORM AND RETURN TO THE HEALTH AND SAFETY SUPERVISOR

MEDICAL RECORDS RELEASE

I hereby authorize ____
(physician's name)

to release to ____
the following medical information from my medical records:

[ ] Complete copy of medical records
[ ] Only medical information as indicated:

____

____

____

I give my permission for this medical information to be used for the following purpose: medical screening, but do not give permission for any other use of re-disclosure of this information.

____
(Name of Employee or Legal Representative)

____
(Name of Company)

____
(Signature of Employee or Legal Representative)

____
(Date of Signature)

____

PHYSICIAN - RETURN FORM TO:

Contractor Employee:Contractor Health and Safety Manager
Address of company where employed

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APPENDIX B

HAZARD COMMUNICATION JOBSITE CHECKLIST

MATERIAL SAFETY DATA SHEETS

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HAZARD COMMUNICATION JOB-SITE CHECKLIST

1. The SHSO obtains a copy of the Federal Standard 20 CFR 1910.1200 hazard communication standards for the site.

2. The PM must communicate in writing and contractually to contractors and subcontractors the applicability of this "Hazard Communication Directive."

3. The SHSO develops and implements the written hazard communication program and distributes a letter to all employees.

4. Procurement requests MSDSs on all purchase orders.

5. The superintendent/General Foreman/Foreman must verify that all employees:

   a. have been trained and informed of job hazards before they work in a Controlled Area.

   b. wear, use, maintain, and service the personal protective equipment that is assigned to them.

6. The SHSO compiles a list of constituents of concern known to be present and posts this list.

7. The SHSO maintains the MSDS file and locates it so that it is available to all work shifts.

8. The SHSO provides information and training on chemicals to employees at the time of initial assignment or whenever a new hazard is introduced to their work area.

9. The SHSO develops and implements a procedure to inform the employees of the hazardous non-routine tasks.

10. The SHSO maintains a record keeping system.

11. The SHSO maintains emergency phone numbers from MSDS in order to obtain information withheld as trade secrets, should injury or illness occur.

MATERIAL SAFETY DATA SHEET # OHS26430 009596

OCCUPATIONAL HEALTH SERVICES, INC.
11 WEST 42ND STREET, 12TH FLOOR
NEW YORK, NEW YORK 10036
1-800-445-MSDS (1-800-445-6737) OR 1-212-789-3535

FOR EMERGENCY SOURCE INFORMATION
CONTACT: 1-615-366-2000

SUBSTANCE IDENTIFICATION

CAS-NUMBER 218-01-9
RTEC-NUMBER GC0700000

SUBSTANCE: 1,2-BENZPHENANTHRENE

TRADE NAMES/SYNONYMS:
CHRYSENE: 1,2-BENZOPHENANTHRENE: BENZ(A)PHENANTHRENE: 1,2,5,6-DIBENZONAPHTH[illegible]: BENZO(A)PHENANTHRENE: RCRA U050: C18H12: OHS26430

CHEMICAL FAMILY:
HYDROCARBON, POLYNUCLEAR

MOLECULAR FORMULA: C18-H12   MOLECULAR WEIGHT: 228.30

CERCLA RATINGS (SCALE 0-3): HEALTH=3 FIRE=1 REACTIVITY=0 PERSISTENCE=3
NFPA RATINGS (SCALE 0-4): HEALTH=3 FIRE=1 REACTIVITY=0

COMPONENTS AND CONTAMINANTS

COMPONENT: 1,2-BENZPHENATHRENE CAS# 218-01-9   PERCENT: 100

OTHER CONTAMINANTS: NONE

EXPOSURE LIMIT:
COAL TAR PITCH VOLATILES (POLYCYCLIC AROMATIC HYDROCARBONS):
0.2 MG/M3 OSHA TWA (AS BENZENE SOLUBLES)
0.2 MG/M3 ACGIH TWA (AS BENZENE SOLUBLES)
ACGIH A1-CONFIRMED HUMAN CARCINOGEN.
0.1 MG/M3 NIOSH RECOMMENDED 10 HOUR TWA (CYCLOHEXANE-EXTRACTABLE FRACTION)

1,2-BENZPHENANTHRENE:
ACGIH A2-SUSPECTED HUMAN CARCINOGEN.

100 POUNDS CERCLA SECTION 103 REPORTABLE QUANTITY
SUBJECT TO CALIFORNIA PROPOSITION 65 CANCER AND/OR REPRODUCTIVE TOXICITY WARNING AND RELEASE REQUIREMENTS- (JANUARY 1, 1990)

PHYSICAL DATA

DESCRIPTION: ODORLESS, COLORLESS, ORTHORHOMBIC BIPYRAMIDAL PLATES WITH A STRONG RED-VIOLET OR BLUE FLUORESCENCE UNDER ULTRAVIOLET LIGHT.

BOILING POINT: 838 F (448 C)   MELTING POINT: 489 F (254 C)

SPECIFIC GRAVITY: 1.274   SOLUBILITY IN WATER: INSOLUBLE

OTHER SOLVENTS (SOLVENT - SOLUBILITY):
SOLUBLE IN BENZENE (HOT); SLIGHTLY SOLUBLE IN ETHANOL,
ETHER, CARBON DISULFIDE, GLACIAL ACETIC ACID, ACETONE, TOLUENE, XYLENE (HOT)

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FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD
SLIGHT FIRE HAZARD WHEN EXPOSED TO HEAT OR FLAME.

FIREFIGHTING MEDIA:
DRY CHEMICAL, CARBON DIOXIDE, WATER SPRAY OR REGULAR FOAM
(1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

FOR LARGER FIRES, USE WATER SPRAY, FOG OR REGULAR FOAM
(1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

FIREFIGHTING:
MOVE CONTAINER FROM FIRE AREA IF YOU CAN DO IT WITHOUT RISK. DO NOT SCATTER SPILLED MATERIAL WITH HIGH-PRESSURE WATER STREAMS. DIKE FIRE-CONTROL WATER FOR LATER DISPOSAL (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5, GUIDE PAGE 31).

USE AGENTS SUITABLE FOR TYPE OF SURROUNDING FIRE. AVOID BREATHING HAZARDOUS VAPORS, KEEP UPWIND.

TOXICITY

1,2-BENZPHENANTHRENE:
TOXICITY DATA: MUTAGENIC DATA (RTECS); TUMORIGENIC DATA (RTECS).
CARCINOGEN STATUS: ANIMAL LIMITED EVIDENCE (IARC GROUP-3). APPLICATION TO THE SKIN OF MICE RESULTED IN SKIN TUMORS. LOCAL TUMORS WERE OBSERVED FOLLOWING ITS SUBCUTANEOUS INJECTION IN MICE. PERINATAL ADMINISTRATION TO MICE BY SUBCUTANEOUS OR INTRAPERITONEAL INJECTION INCREASED THE INCIDENCES OF LIVER TUMORS.
LOCAL EFFECTS: IRRITANT- INHALATION, SKIN, EYE.
ACUTE TOXICITY LEVEL: NO DATA AVAILABLE.
TARGET EFFECTS: SENSITIZER- SKIN. POISONING MAY AFFECT THE LUNGS.*

* BASED ON GENERAL INFORMATION ON COAL TAR PITCH VOLATILES.

HEALTH EFFECTS AND FIRST AID

INHALATION:
1,2-BENZPHENANTRENE:
IRRITANT.
ACUTE EXPOSURE- MAY CAUSE RESPIRATORY IRRITATION, COUGH, DYSPNEA, AND PULMONARY EDEMA.
CHRONIC EXPOSURE- REPEATED OR PROLONGED EXPOSURE MAY CAUSE BRONCHITIS. EXPOSURE IS ASSOCIATED WITH CANCERS OF THE LUNGS, BLADDER, KIDNEYS, AND AND GASTROINTESTINAL TRACT.

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SKIN CONTACT:
1,2-BENZPHENANTHRENE:
IRRITANT/SENSITIZER/LIMITED ANIMAL CARCINOGEN.
ACUTE EXPOSURE- DELAYED EFFECTS ARE ERYTHEMA AND SWELLING, WHICH APPEARS A FEW HOURS AFTER EXPOSURE OF SKIN SURFACES TO ULTRAVIOLET LIGHT. HYPERMELANOSIS IS COMMON. INTENSE CONTACT HAS CAUSED ACNE AND/OR FOLLICULITIS. DESQUAMATION, PIGMENTATION, DERMATITIS, AND THERMAL BURNS HAVE ALSO OCCURRED. ALLERGIC DERMATITIS IS RARE.
CHRONIC EXPOSURE- APPLICATION TO THE SKIN OF MICE HAS PRODUCED SKIN TUMORS.

EYE CONTACT:
1,2-BENZPHENANTRENE:
IRRITANT.
ACUTE EXPOSURE- DELAYED IRRITATION MAY OCCUR, WITH CONJUNCTIVAL ERYTHEMA, LACRIMATION, PALPEBRAL EDEMA, PHOTOPHOBIA, AND CORNEAL ULCERATION.
CHRONIC EXPOSURE- PROLONGED EXPOSURE MAY PRODUCE THE SAME EFFECTS AS ACUTE EXPOSURE.

INGESTION:
1,2-BENZPHENANTRENE:
ACUTE EXPOSURE- INGESTION MAY CAUSE DIZZINESS, NAUSEA AND VOMITING, WEAKNESS, HEADACHE, TIGHTNESS IN THE CHEST, AND STAGGERING. IF LARGER AMOUNTS HAVE BEEN INGESTED, THESE SYMPTOMS MAY PROGRESS TO VISUAL DISTURBANCES, TREMORS, SHALLOW AND RAPID RESPIRATION, CONVULSIONS AND COMA. VIOLENT EXCITEMENT OR DELIRIUM MAY PRECEDE UNCONSCIOUSNESS. KIDNEY OR LIVER DAMAGE MAY OCCUR.
CHRONIC EXPOSURE- HAS NOT BEEN REPORTED IN HUMANS.

ANTIDOTE:
NO SPECIFIC ANTIDOTE. TREAT SYMPTOMATICALLY AND SUPPORTIVELY.

REACTIVITY SECTION

REACTIVITY:
STABLE UNDER NORMAL TEMPERATURES AND PRESSURES.

INCOMPATIBILITIES:
1,2-BENZANTHRACENE:
OXIDIZERS (STRONG): FIRE AND EXPLOSION HAZARD.

DECOMPOSITION:
THERMAL DECOMPOSITION MAY RELEASE ACRID SMOKE AND IRRITATING FUMES.

POLYMERIZATION:
HAZARDOUS POLYMERIZATION HAS NOT BEEN REPORTED TO OCCUR UNDER NORMAL TEMPERATURES AND PRESSURES.

STORAGE-DISPOSAL

OBSERVE ALL FEDERAL, STATE AND LOCAL REGULATIONS WHEN STORING OR DISPOSING OF THIS SUBSTANCE. FOR ASSISTANCE, CONTACT THE DISTRICT DIRECTOR OF THE ENVIRONMENTAL PROTECTION AGENCY.

STORAGE

STORE AWAY FROM INCOMPATIBLE SUBSTANCES. 009599

CONDITIONS TO AVOID

MAY BURN BUT DOES NOT IGNITE READILY. AVOID CONTACT WITH STRONG OXIDIZERS, EXCESSIVE HEAT, SPARKS, OR OPEN FLAME.

SPILLS AND LEAKS

SOIL-RELEASE:
DIG HOLDING AREA SUCH AS LAGOON, POND OR PIT FOR CONTAINMENT.

USE PROTECTIVE COVER SUCH AS A PLASTIC SHEET TO PREVENT MATERIAL FROM DISSOLVING IN FIRE EXTINGUISHING WATER OR RAIN.

WATER-SPILL:
USE ACTIVATED CARBON TO ABSORB SPILLED SUBSTANCE THAT IS DISSOLVED.

USE SUCTION HOSES TO REMOVE TRAPPED SPILL MATERIAL.

USE MECHANICAL DREDGES OR LIFTS TO EXTRACT IMMOBILIZED MASSES OF POLLUTION AND PRECIPITATES.

THE CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT OF 1986 (PROPOSITION 65) PROHIBITS CONTAMINATING ANY KNOWN SOURCE OF DRINKING WATER WITH SUBSTANCES KNOWN TO CAUSE CANCER AND/OR REPRODUCTIVE TOXICITY.

OCCUPATIONAL-SPILL:
SWEEP UP AND PLACE IN SUITABLE CLEAN, DRY CONTAINERS FOR RECLAMATION OR LATER DISPOSAL. DO NOT FLUSH SPILLED MATERIAL INTO SEWER. KEEP UNNECESSARY PEOPLE AWAY.

REPORTABLE QUANTITY (RQ): 100 POUNDS
THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) SECTION 304 REQUIRES THAT A RELEASE EQUAL TO OR GREATER THAN THE REPORTABLE QUANTITY FOR THIS SUBSTANCE BE IMMEDIATELY REPORTED TO THE LOCAL EMERGENCY PLANNING COMMITTEE AND THE STATE EMERGENCY RESPONSE COMMISSION (40 CFR 355.40). IF THE RELEASE OF THIS SUBSTANCE IS REPORTABLE UNDER CERCLA SECTION 103, THE NATIONAL RESPONSE CENTER MUST BE NOTIFIED IMMEDIATELY AT (800) 424-8802 OR (202) 426-2675 IN THE METROPOLITAN WASHINGTON, D.C. AREA (40 CFR 302.6).

PROTECTIVE EQUIPMENT SECTION

VENTILATION:
PROVIDE LOCAL EXHAUST VENTILATION AND/OR GENERAL DILUTION VENTILATION TO MEET PUBLISHED EXPOSURE LIMITS.

RESPIRATOR:
THE FOLLOWING RESPIRATORS ARE RECOMMENDED BASED ON INFORMATION FOUND IN THE PHYSICAL DATA, TOXICITY AND HEALTH EFFECTS SECTIONS. THEY ARE RANKED IN ORDER FROM MINIMUM TO MAXIMUM RESPIRATORY PROTECTION.
THE SPECIFIC RESPIRATOR SELECTED MUST BE BASED ON CONTAMINATION LEVELS FOUND IN THE WORK PLACE, MUST BE BASED ON THE SPECIFIC OPERATION, MUST NOT EXCEED THE WORKING LIMITS OF THE RESPIRATOR AND MUST BE JOINTLY APPROVED BY THE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH AND THE MINE SAFETY AND HEALTH ADMINISTRATION (NIOSH-MSHA).

ANY TYPE 'C' SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE OR WITH A FULL FACEPIECE, HELMET OR HOOD OPERATED IN CONTINOUS-FLOW MODE.

ANY SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

FOR FIREFIGHTING AND OTHER IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONDITIONS:

ANY SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

ANY SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE AND OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE IN COMBINATION WITH AN AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

CLOTHING:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE (IMPERVIOUS) CL[illegible] AND EQUIPMENT TO PREVENT ANY POSSIBILITY OF SKIN CONTACT WITH THIS SUBSTANCE.

GLOVES:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE GLOVES TO PREVENT CONTACT WITH THIS SUBSTANCE.

EYE PROTECTION:
EMPLOYEE MUST WEAR SPLASH-PROOF OR DUST-RESISTANT SAFETY GOGGLES AND A FACESHIELD TO PREVENT CONTACT WITH THIS SUBSTANCE.

EMERGENCY WASH FACILITIES:
WHERE THERE IS ANY POSSIBILITY THAT AN EMPLOYEE'S EYES AND/OR SKIN MAY BE EXPOSED TO THIS SUBSTANCE, THE EMPLOYER SHOULD PROVIDE AN EYE WASH FOUNTAIN AND QUICK DRENCH SHOWER WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

AUTHORIZED BY- OCCUPATIONAL HEALTH SERVICES, INC.

CREATION DATE: 03/19/85 REVISION DATE: 12/03/90

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MATERIAL SAFETY DATA SHEET OHS02710

OCCUPATIONAL HEALTH SERVICES, INC.
11 WEST 42ND STREET, 12TH FLOOR
NEW YORK, NEW YORK 10036
1-800-445-MSDS (1-800-445-6737) OR 1-212-789-3535

FOR EMERGENCY SOURCE INFORMATION
CONTACT: 1-615-366-2000

009601

SUBSTANCE IDENTIFICATION

CAS-NUMBER 207-08-9
RTEC-NUMBER DF6350000

SUBSTANCE: BENZO(K)FLUORANTHENE

TRADE NAMES/SYNONYMS:
11,12-BENZO(K)FLUORANTHENE: OHS02710

CHEMICAL FAMILY:
HYDROCARBON, POLYNUCLEAR

MOLECULAR FORMULA: C20-H12 MOLECULAR WEIGHT: 252.32

CERCLA RATINGS (SCALE 0-3): HEALTH=U FIRE=1 REACTIVITY=0 PERSISTENCE=3
NFPA RATINGS (SCALE 0-4): HEALTH=U FIRE=1 REACTIVITY=0

COMPONENTS AND CONTAMINANTS

COMPONENT: BENZO(K)FLUORANTHENE CAS# 207-08-9 PERCENT: 100

OTHER CONTAMINANTS: NONE

EXPOSURE LIMIT:
COAL TAR PITCH VOLATILES (POLYCYCLIC AROMATIC HYDROCARBONS):
0.2 MG/M3 OSHA TWA (AS BENZENE SOLUBLES)
0.2 MG/M3 ACGIH TWA (AS BENZENE SOLUBLES)
ACGIH A1-CONFIRMED HUMAN CARCINOGEN.
0.1 MG/M3 NIOSH RECOMMENDED 10 HOUR TWA (CYCLOHEXANE-EXTRACTABLE FRACTION)

BENZO(K)FLUORANTHENE:
5000 POUNDS CERCLA SECTION 103 REPORTABLE QUANTITY
SUBJECT TO CALIFORNIA PROPOSITION 65 CANCER AND/OR REPRODUCTIVE TOXICITY WARNING AND RELEASE REQUIREMENTS- (JULY 1, 1987)

PHYSICAL DATA

DESCRIPTION: SOLID

SOLUBILITY IN WATER: INSOLUBLE

FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD
SLIGHT FIRE HAZARD WHEN EXPOSED TO HEAT OR FLAME.

009602

FIREFIGHTING MEDIA:
DRY CHEMICAL, CARBON DIOXIDE, WATER SPRAY OR REGULAR FOAM
(1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

FOR LARGER FIRES, USE WATER SPRAY, FOG OR REGULAR FOAM
(1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

FIREFIGHTING:
MOVE CONTAINER FROM FIRE AREA IF YOU CAN DO IT WITHOUT RISK. DO NOT SCATTER SPILLED MATERIAL WITH HIGH-PRESSURE WATER STREAMS. DIKE FIRE-CONTROL WATER FOR LATER DISPOSAL (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5, GUIDE PAGE 31).

USE AGENTS SUITABLE FOR TYPE OF SURROUNDING FIRE. AVOID BREATHING HAZARDOUS VAPORS, KEEP UPWIND.

TOXICITY

BENZO(K)FLUORANTHENE:
MUTAGENIC DATA (RTECS); TUMORIGENIC DATA (RTECS).
CARCINOGEN STATUS: ANTICIPATED HUMAN CARCINOGEN (NTP); ANIMAL SUFFICIENT EVIDENCE (IARC GROUP-2B). BENZO(K)FLUORANTHENE PRODUCED A FEW SKIN TUMORS IN TWO STRAINS OF MICE FOLLOWING SKIN APPLICATION; AS WELL AS AN INITIATOR OF SKIN CARCINOGENESIS. SUBCUTANEOUS INJECTION PRODUCED SARCOMAS AT THE SITE OF INJECTION IN MICE AND SQUAMOUS-CELL CARCINOMAS OF THE LUNG IN RATS FOLLOWING DIRECT INJECTION INTO PULMONARY TISSUE.

BENZO(K)FLUORANTHENE IS A COAL TAR PITCH VOLATILE THAT MAY IRRITATE THE EYES, SKIN, AND MUCOUS MEMBRANES, AND CAUSE SKIN SENSITIZATION AND PHOTOSENSITIZATION. REPEATED EXPOSURE TO COAL TAR PITCH VOLATILES HAS BEEN ASSOCIATED WITH AN INCREASED RISK OF DEVELOPING BRONCHITIS AND CANCER OF THE LUNGS, BLADDER, SKIN, AND KIDNEYS.

HEALTH EFFECTS AND FIRST AID

INHALATION:
BENZO(K)FLUORANTHENE:
IRRITANT.

ACUTE EXPOSURE- MAY CAUSE RESPIRATORY IRRITATION, COUGH, DYSPNEA, AND PULMONARY EDEMA.

CHRONIC EXPOSURE- REPEATED OR PROLONGED EXPOSURE MAY CAUSE BRONCHITIS. EXPOSURE IS ASSOCIATED WITH CANCERS OF THE LUNGS, BLADDER, KIDNEYS, AND AND GASTROINTESTINAL TRACT.

FIRST AID- REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

SKIN CONTACT:
BENZO(K)FLUORANTHENE:
IRRITANT/SENSITIZER/CARCINOGEN.

ACUTE EXPOSURE- DELAYED EFFECTS ARE ERYTHEMA AND SWELLING, WHICH APPEARS A FEW HOURS AFTER EXPOSURE OF SKIN SURFACES TO ULTRAVIOLET LIGHT. HYPERMELANOSIS IS COMMON. INTENSE CONTACT HAS CAUSED ACNE AND/OR FOLLICULITIS. DESQUAMATION, PIGMENTATION, DERMATITIS, AND THERMAL BURNS HAVE ALSO OCCURRED. ALLERGIC DERMATITIS IS RARE. 009603

CHRONIC EXPOSURE- APPLICATION TO TWO STRAINS OF MICE HAS PRODUCED SKIN TUMORS. LEUKODERMA MAY ALSO OCCUR.

FIRST AID- REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

EYE CONTACT:
BENZO(K)FLUORANTHENE:
IRRITANT.

ACUTE EXPOSURE- DELAYED IRRITATION MAY OCCUR, WITH CONJUNCTIVAL ERYTHEMA, LACRIMATION, PALPEBRAL EDEMA, PHOTOPHOBIA, AND CORNEAL ULCERATION.

CHRONIC EXPOSURE- PROLONGED EXPOSURE MAY PRODUCE THE SAME EFFECTS AS ACUTE EXPOSURE.

FIRST AID- WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

INGESTION:
BENZO(K)FLUORANTHENE:

ACUTE EXPOSURE- INGESTION MAY CAUSE DIZZINESS, NAUSEA AND VOMITING, WEAKNESS, HEADACHE, TIGHTNESS IN THE CHEST, AND STAGGERING. IF LARGER AMOUNTS HAVE BEEN INGESTED, THESE SYMPTOMS MAY PROGRESS TO VISUAL DISTURBANCES, TREMORS, SHALLOW AND RAPID RESPIRATION, CONVULSIONS AND COMA. VIOLENT EXCITEMENT OR DELIRIUM MAY PRECEDE UNCONSCIOUSNESS. KIDNEY OR LIVER DAMAGE MAY OCCUR.

CHRONIC EXPOSURE- HAS NOT BEEN REPORTED IN HUMANS.

FIRST AID- IF VICTIM IS CONSCIOUS, REMOVE INGESTED POISON BY GASTRIC LAVAGE, WITH ACTIVATED CHARCOAL AND A CUFFED ENDOTRACHEAL TUBE TO PREVENT ASPIRATION. IN THE ABSENCE OF DEPRESSION, CONVULSION OR IMPAIRED GAG REFLEX, IPECAC EMESIS CAN ALSO BE DONE WITHOUT INCREASING THE HAZARD OF ASPIRATION. WHEN VOMITING OCCURS, HOLD THE PATIENT WITH HEAD LOWER THAN HIPS TO HELP PREVENT PULMONARY ASPIRATION. AFTER VOMITING STOPS, GIVE 30 TO 60 ML OF FLEET'S PHOSPHO-SODA DILUTED 1:4 IN WATER. (DREISBACH, HANDBOOK OF POISONING, 11TH ED.).

ANTIDOTE:
NO SPECIFIC ANTIDOTE. TREAT SYMPTOMATICALLY AND SUPPORTIVELY.

REACTIVITY SECTION

REACTIVITY:
STABLE UNDER NORMAL TEMPERATURES AND PRESSURES.

INCOMPATIBILITIES:
CONTACT WITH STRONG OXIDIZERS MAY CAUSE FIRES AND EXPLOSIONS.

DECOMPOSITION:

THERMAL DECOMPOSITION MAY RELEASE ACRID SMOKE AND IRRITATING FUMES.

POLYMERIZATION:
HAZARDOUS POLYMERIZATION HAS NOT BEEN REPORTED TO OCCUR UNDER NORMAL TEMPERATURES AND PRESSURES.

009604

STORAGE-DISPOSAL

OBSERVE ALL FEDERAL, STATE AND LOCAL REGULATIONS WHEN STORING OR DISPOSING OF THIS SUBSTANCE. FOR ASSISTANCE, CONTACT THE DISTRICT DIRECTOR OF THE ENVIRONMENTAL PROTECTION AGENCY.

CONDITIONS TO AVOID

MAY BURN BUT DOES NOT IGNITE READILY. AVOID CONTACT WITH STRONG OXIDIZERS, EXCESSIVE HEAT, SPARKS, OR OPEN FLAME.

SPILLS AND LEAKS

WATER-SPILL:
THE CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT OF 1986 (PROPOSITION 65) PROHIBITS CONTAMINATING ANY KNOWN SOURCE OF DRINKING WATER WITH SUBSTANCES KNOWN TO CAUSE CANCER AND/OR REPRODUCTIVE TOXICITY.

OCCUPATIONAL-SPILL:
SWEEP UP AND PLACE IN SUITABLE CLEAN, DRY CONTAINERS FOR RECLAMATION OR LATER DISPOSAL. DO NOT FLUSH SPILLED MATERIAL INTO SEWER. KEEP UNNECESSARY PEOPLE AWAY.

REPORTABLE QUANTITY (RQ): 5000 POUNDS
THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) SECTION 304 REQUIRES THAT A RELEASE EQUAL TO OR GREATER THAN THE REPORTABLE QUANTITY FOR THIS SUBSTANCE BE IMMEDIATELY REPORTED TO THE LOCAL EMERGENCY PLANNING COMMITTEE AND THE STATE EMERGENCY RESPONSE COMMISSION (40 CFR 355.40). IF THE RELEASE OF THIS SUBSTANCE IS REPORTABLE UNDER CERCLA SECTION 103, THE NATIONAL RESPONSE CENTER MUST BE NOTIFIED IMMEDIATELY AT (800) 424-8802 OR (202) 426-2675 IN THE METROPOLITAN WASHINGTON, D.C. AREA (40 CFR 302.6).

PROTECTIVE EQUIPMENT SECTION

VENTILATION:
PROVIDE LOCAL EXHAUST VENTILATION AND/OR GENERAL DILUTION VENTILATION TO MEET PUBLISHED EXPOSURE LIMITS.

RESPIRATOR:
THE FOLLOWING RESPIRATORS ARE RECOMMENDED BASED ON INFORMATION FOUND IN THE PHYSICAL DATA, TOXICITY AND HEALTH EFFECTS SECTIONS. THEY ARE RANKED IN ORDER FROM MINIMUM TO MAXIMUM RESPIRATORY PROTECTION.

THE SPECIFIC RESPIRATOR SELECTED MUST BE BASED ON CONTAMINATION LEVELS FOUND IN THE WORK PLACE, MUST BE BASED ON THE SPECIFIC OPERATION, MUST NOT EXCEED THE WORKING LIMITS OF THE RESPIRATOR AND MUST BE JOINTLY APPROVED BY THE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH AND THE MINE SAFETY AND HEALTH ADMINISTRATION (NIOSH-MSHA). 009605

ANY DUST AND MIST RESPIRATOR WITH A FULL FACEPIECE.

ANY AIR-PURIFYING FULL FACEPIECE RESPIRATOR WITH A HIGH-EFFICIENCY PARTICULATE FILTER.

ANY POWERED AIR-PURIFYING RESPIRATOR WITH A TIGHT-FITTING FACEPIECE AND HIGH-EFFICIENCY PARTICULATE FILTER.

ANY TYPE 'C' SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE OR WITH A FULL FACEPIECE, HELMET OR HOOD OPERATED IN CONTINUOUS-FLOW MODE.

ANY SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

FOR FIREFIGHTING AND OTHER IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONDITIONS:

ANY SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

ANY SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE AND OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE IN COMBINATION WITH AN AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

CLOTHING:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE (IMPERVIOUS) CLOTHING AND EQUIPMENT TO PREVENT ANY POSSIBILITY OF SKIN CONTACT WITH THIS SUBSTANCE.

GLOVES:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE GLOVES TO PREVENT CONTACT WITH THIS SUBSTANCE.

EYE PROTECTION:
EMPLOYEE MUST WEAR SPLASH-PROOF OR DUST-RESISTANT SAFETY GOGGLES AND A FACESHIELD TO PREVENT CONTACT WITH THIS SUBSTANCE.

EMERGENCY WASH FACILITIES:
WHERE THERE IS ANY POSSIBILITY THAT AN EMPLOYEE'S EYES AND/OR SKIN MAY BE EXPOSED TO THIS SUBSTANCE, THE EMPLOYER SHOULD PROVIDE AN EYE WASH FOUNTAIN AND QUICK DRENCH SHOWER WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

AUTHORIZED BY- OCCUPATIONAL HEALTH SERVICES, INC.

CREATION DATE: 03/18/85 REVISION DATE: 12/03/90

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MATERIAL SAFETY DATA SHEET OHS02680

OCCUPATIONAL HEALTH SERVICES, INC.
11 WEST 42ND STREET, 12TH FLOOR
NEW YORK, NEW YORK 10036
1-800-445-MSDS (1-800-445-6737) OR 1-212-789-3535

FOR EMERGENCY SOURCE INFORMATIO
CONTACT: 1-615-366-2000

009606

SUBSTANCE IDENTIFICATION

CAS-NUMBER 205-99-2
RTEC-NUMBER CU1400000

SUBSTANCE: BENZO(B)FLUORANTHENE

TRADE NAMES/SYNONYMS:
BENZ(E)ACEPHENANTHRYLENE: 3,4-BEN(E)ACEPHENANTHRYLENE: 2,3-BENZFLUORANTHENE: 3,4-BENZFLUORANTHENE: BENZO(E)FLUORANTHENE: B(B)F: 2,3-BENZOFLUORANTHENE: 3,4-BENZOFLUORANTHENE: C20H12: OHS02680

CHEMICAL FAMILY:
HYDROCARBON, POLYNUCLEAR

MOLECULAR FORMULA: C20-H12   MOLECULAR WEIGHT: 252.32

CERCLA RATINGS (SCALE 0-3): HEALTH=3 FIRE=1 REACTIVITY=0 PERSISTENCE=3
NFPA RATINGS (SCALE 0-4): HEALTH=3 FIRE=1 REACTIVITY=0

COMPONENTS AND CONTAMINANTS

COMPONENT: BENZO(B)FLUORANTHENE CAS# 205-99-2   PERCENT: 100

OTHER CONTAMINANTS: NONE

EXPOSURE LIMIT:
COAL TAR PITCH VOLATILES (POLYCYCLIC AROMATIC HYDROCARBONS):
0.2 MG/M3 OSHA TWA (AS BENZENE SOLUBLES)
0.2 MG/M3 ACGIH TWA (AS BENZENE SOLUBLES)
ACGIH A1-CONFIRMED HUMAN CARCINOGEN.
0.1 MG/M3 NIOSH RECOMMENDED 10 HOUR TWA (CYCLOHEXANE-EXTRACTABLE FRACTION)

BENZO(B)FLUORANTHENE:
1 POUND CERCLA SECTION 103 REPORTABLE QUANTITY
SUBJECT TO CALIFORNIA PROPOSITION 65 CANCER AND/OR REPRODUCTIVE TOXICITY WARNING AND RELEASE REQUIREMENTS- (JULY 1, 1987)

PHYSICAL DATA

DESCRIPTION: COLORLESS NEEDLES.

MELTING POINT: 334 F (168 C)   SOLUBILITY IN WATER: INSOLUBLE

OTHER SOLVENTS (SOLVENT - SOLUBILITY):
ORGANIC SOLVENTS

009607

FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD
SLIGHT FIRE HAZARD WHEN EXPOSED TO HEAT OR FLAME.

FIREFIGHTING MEDIA:
DRY CHEMICAL, CARBON DIOXIDE, WATER SPRAY OR REGULAR FOAM (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

FOR LARGER FIRES, USE WATER SPRAY, FOG OR REGULAR FOAM (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

FIREFIGHTING:
MOVE CONTAINER FROM FIRE AREA IF YOU CAN DO IT WITHOUT RISK. DO NOT SCATTER SPILLED MATERIAL WITH HIGH-PRESSURE WATER STREAMS. DIKE FIRE-CONTROL WATER FOR LATER DISPOSAL (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5, GUIDE PAGE 31).

USE AGENTS SUITABLE FOR TYPE OF SURROUNDING FIRE. AVOID BREATHING HAZARDOUS VAPORS, KEEP UPWIND.

TOXICITY

BENZO(B)FLUORANTHENE:
TOXICITY DATA: MUTAGENIC DATA (RTECS); TUMORIGENIC DATA (RTECS).
CARCINOGEN STATUS: ANTICIPATED HUMAN CARCINOGEN (NTP); ANIMAL SUFFICIENT EVIDENCE (IARC GROUP-2B). IT HAS PRODUCED SKIN TUMORS IN MICE FOLLOWING REPEATED SKIN PAINTINGS. IT IS ALSO AN INITIATOR OF SKIN CARCINOGENESIS IN MICE AND PRODUCED LOCAL SARCOMAS AFTER SUBCUTANEOUS INJECTION.
LOCAL EFFECTS: IRRITANT- INHALATION, SKIN, EYE.
ACUTE TOXICITY LEVEL: NO DATA AVAILABLE.
TARGET EFFECTS: SENSITIZER- SKIN. POISONING MAY AFFECT THE LUNGS.

HEALTH EFFECTS AND FIRST AID

INHALATION:
BENZO(B)FLUORANTHENE:
IRRITANT.
ACUTE EXPOSURE- MAY CAUSE RESPIRATORY IRRITATION, COUGH, DYSPNEA, AND PULMONARY EDEMA.
CHRONIC EXPOSURE- REPEATED OR PROLONGED EXPOSURE MAY CAUSE BRONCHITIS. EXPOSURE IS ASSOCIATED WITH CANCERS OF THE LUNGS, BLADDER, KIDNEYS, AND AND GASTROINTESTINAL TRACT.

FIRST AID- REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

SKIN CONTACT:
BENZO(B)FLUORANTHENE:

IRRITANT/SENSITIZER/CARCINOGEN.

ACUTE EXPOSURE- DELAYED EFFECTS ARE ERYTHEMA AND SWELLING, WHICH APPEARS A FEW HOURS AFTER EXPOSURE OF SKIN SURFACES TO ULTRAVIOLET LIGHT. HYPERMELANOSIS IS COMMON. INTENSE CONTACT HAS CAUSED ACNE AND/OR FOLLICULITIS. DESQUAMATION, PIGMENTATION, DERMATITIS, AND THERMAL BURNS HAVE ALSO OCCURRED. ALLERGIC DERMATITIS IS RARE. 009608

CHRONIC EXPOSURE- HAS PRODUCED SKIN TUMORS IN MICE FOLLOWING REPEATED SKIN PAINTINGS. MAY ALSO PRODUCE LEUKODERMA.

FIRST AID- REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

EYE CONTACT:
BENZO(B)FLUORANTHENE:
IRRITANT.

ACUTE EXPOSURE- DELAYED IRRITATION MAY OCCUR, WITH CONJUNCTIVAL ERYTHEMA, LACRIMATION, PALPEBRAL EDEMA, PHOTOPHOBIA, AND CORNEAL ULCERATION.

CHRONIC EXPOSURE- PROLONGED EXPOSURE MAY PRODUCE THE SAME EFFECTS AS ACUTE EXPOSURE.

FIRST AID- WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

INGESTION:
BENZO(B)FLUORANTHENE:

ACUTE EXPOSURE- INGESTION MAY CAUSE DIZZINESS, NAUSEA AND VOMITING, WEAKNESS, HEADACHE, TIGHTNESS IN THE CHEST, AND STAGGERING. IF LARGER AMOUNTS HAVE BEEN INGESTED, THESE SYMPTOMS MAY PROGRESS TO VISUAL DISTURBANCES, TREMORS, SHALLOW AND RAPID RESPIRATION, CONVULSIONS AND COMA. VIOLENT EXCITEMENT OR DELIRIUM MAY PRECEDE UNCONSCIOUSNESS. KIDNEY OR LIVER DAMAGE MAY OCCUR.

CHRONIC EXPOSURE- HAS NOT BEEN REPORTED IN HUMANS.

FIRST AID- IF VICTIM IS CONSCIOUS, REMOVE INGESTED POISON BY GASTRIC LAVAGE, WITH ACTIVATED CHARCOAL AND A CUFFED ENDOTRACHEAL TUBE TO PREVENT ASPIRATION. IN THE ABSENCE OF DEPRESSION, CONVULSION OR IMPAIRED GAG REFLEX, IPECAC EMESIS CAN ALSO BE DONE WITHOUT INCREASING THE HAZARD OF ASPIRATION. WHEN VOMITING OCCURS, HOLD THE PATIENT WITH HEAD LOWER THAN HIPS TO HELP PREVENT PULMONARY ASPIRATION. AFTER VOMITING STOPS, GIVE 30 TO 60 ML OF FLEET'S PHOSPHO-SODA DILUTED 1:4 IN WATER. (DREISBACH, HANDBOOK OF POISONING, 11TH ED.).

ANTIDOTE:
NO SPECIFIC ANTIDOTE. TREAT SYMPTOMATICALLY AND SUPPORTIVELY.

REACTIVITY SECTION

REACTIVITY:
STABLE UNDER NORMAL TEMPERATURES AND PRESSURES.

INCOMPATIBILITIES:
BENZO(B)FLUORANTHENE:
OXIDIZERS (STRONG): FIRE AND EXPLOSION HAZARD.

DECOMPOSITION:
THERMAL DECOMPOSITION MAY RELEASE ACRID SMOKE AND IRRITATING FUMES.

POLYMERIZATION:
HAZARDOUS POLYMERIZATION HAS NOT BEEN REPORTED TO OCCUR UNDER NORMAL TEMPERATURES AND PRESSURES.

009609

STORAGE-DISPOSAL

OBSERVE ALL FEDERAL, STATE AND LOCAL REGULATIONS WHEN STORING OR DISPOSING OF THIS SUBSTANCE. FOR ASSISTANCE, CONTACT THE DISTRICT DIRECTOR OF THE ENVIRONMENTAL PROTECTION AGENCY.

CONDITIONS TO AVOID

MAY BURN BUT DOES NOT IGNITE READILY. AVOID CONTACT WITH STRONG OXIDIZERS, EXCESSIVE HEAT, SPARKS, OR OPEN FLAME.

SPILLS AND LEAKS

SOIL-RELEASE:
DIG HOLDING AREA SUCH AS LAGOON, POND OR PIT FOR CONTAINMENT.

USE PROTECTIVE COVER SUCH AS A PLASTIC SHEET TO PREVENT MATERIAL FROM DISSOLVING IN FIRE EXTINGUISHING WATER OR RAIN.

WATER-SPILL:
USE ACTIVATED CARBON TO ABSORB SPILLED SUBSTANCE THAT IS DISSOLVED.

USE SUCTION HOSES TO REMOVE TRAPPED SPILL MATERIAL.

USE MECHANICAL DREDGES OR LIFTS TO EXTRACT IMMOBILIZED MASSES OF POLLUTION AND PRECIPITATES.

THE CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT OF 1986 (PROPOSITION 65) PROHIBITS CONTAMINATING ANY KNOWN SOURCE OF DRINKING WATER WITH SUBSTANCES KNOWN TO CAUSE CANCER AND/OR REPRODUCTIVE TOXICITY.

OCCUPATIONAL-SPILL:
SWEEP UP AND PLACE IN SUITABLE CLEAN, DRY CONTAINERS FOR RECLAMATION OR LATER DISPOSAL. DO NOT FLUSH SPILLED MATERIAL INTO SEWER. KEEP UNNECESSARY PEOPLE AWAY.

REPORTABLE QUANTITY (RQ): 1 POUND
THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) SECTION 304 REQUIRES THAT A RELEASE EQUAL TO OR GREATER THAN THE REPORTABLE QUANTITY FOR THIS SUBSTANCE BE IMMEDIATELY REPORTED TO THE LOCAL EMERGENCY PLANNING COMMITTEE AND THE STATE EMERGENCY RESPONSE COMMISSION (40 CFR 355.40). IF THE RELEASE OF THIS SUBSTANCE IS REPORTABLE UNDER CERCLA SECTION 103, THE NATIONAL RESPONSE CENTER MUST BE NOTIFIED IMMEDIATELY AT (800) 424-8802 OR (202) 426-2675 IN THE METROPOLITAN WASHINGTON, D.C. AREA (40 CFR 302.6).

009610

PROTECTIVE EQUIPMENT SECTION

VENTILATION:
PROVIDE LOCAL EXHAUST VENTILATION AND/OR GENERAL DILUTION VENTILATION TO MEET PUBLISHED EXPOSURE LIMITS.

RESPIRATOR:
THE FOLLOWING RESPIRATORS ARE RECOMMENDED BASED ON INFORMATION FOUND IN THE PHYSICAL DATA, TOXICITY AND HEALTH EFFECTS SECTIONS. THEY ARE RANKED IN ORDER FROM MINIMUM TO MAXIMUM RESPIRATORY PROTECTION.
THE SPECIFIC RESPIRATOR SELECTED MUST BE BASED ON CONTAMINATION LEVELS FOUND IN THE WORK PLACE, MUST BE BASED ON THE SPECIFIC OPERATION, MUST NOT EXCEED THE WORKING LIMITS OF THE RESPIRATOR AND MUST BE JOINTLY APPROVED BY THE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH AND THE MINE SAFETY AND HEALTH ADMINISTRATION (NIOSH-MSHA).

ANY TYPE 'C' SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE OR WITH A FULL FACEPIECE, HELMET OR HOOD OPERATED IN CONTINOUS-FLOW MODE.

ANY SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

FOR FIREFIGHTING AND OTHER IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONDITIONS:

ANY SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

ANY SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE AND OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE IN COMBINATION WITH AN AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

CLOTHING:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE (IMPERVIOUS) CLOTHING AND EQUIPMENT TO PREVENT ANY POSSIBILITY OF SKIN CONTACT WITH THIS SUBSTANCE.

GLOVES:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE GLOVES TO PREVENT CONTACT WITH THIS SUBSTANCE.

EYE PROTECTION:
EMPLOYEE MUST WEAR SPLASH-PROOF OR DUST-RESISTANT SAFETY GOGGLES AND A FACESHIELD TO PREVENT CONTACT WITH THIS SUBSTANCE.

EMERGENCY WASH FACILITIES:
WHERE THERE IS ANY POSSIBILITY THAT AN EMPLOYEE'S EYES AND/OR SKIN MAY BE EXPOSED TO THIS SUBSTANCE, THE EMPLOYER SHOULD PROVIDE AN EYE WASH FOUNTAIN AND QUICK DRENCH SHOWER WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

AUTHORIZED BY- OCCUPATIONAL HEALTH SERVICES, INC.

CREATION DATE: 03/18/85 REVISION DATE: 12/03/90

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009611

MATERIAL SAFETY DATA SHEET OHS02670

OCCUPATIONAL HEALTH SERVICES, INC.
11 WEST 42ND STREET, 12TH FLOOR
NEW YORK, NEW YORK 10036
1-800-445-MSDS (1-800-445-6737) OR 1-212-789-3535

FOR EMERGENCY SOURCE INFORMATION
CONTACT: 1-615-366-2000

SUBSTANCE IDENTIFICATION

CAS-NUMBER 50-32-8
RTEC-NUMBER DJ3675000

009612

SUBSTANCE: BENZO(A)PYRENE

TRADE NAMES/SYNONYMS:
3,4-BENZOPYRENE: 6,7-BENZOPYRENE: BENZO(D,E,F)-CHRYSENE: B(A)P: 3,4-BP: 3,4-BENZPYRENE: 3,4-BENZ(A)PYRENE: 3,4-BENZYLPYRENE: RCRA U022: C20H12: OHS02670

CHEMICAL FAMILY:
HYDROCARBON, POLYNUCLEAR

MOLECULAR FORMULA: C20-H12 MOLECULAR WEIGHT: 252.32

CERCLA RATINGS (SCALE 0-3): HEALTH=3 FIRE=1 REACTIVITY=0 PERSISTENCE=3
NFPA RATINGS (SCALE 0-4): HEALTH=U FIRE=1 REACTIVITY=0

COMPONENTS AND CONTAMINANTS

COMPONENT: BENZO(A)PYRENE CAS# 50-32-8 PERCENT: 100

OTHER CONTAMINANTS: NONE

EXPOSURE LIMIT:
COAL TAR PITCH VOLATILES (POLYCYCLIC AROMATIC HYDROCARBONS):
0.2 MG/M3 OSHA TWA (AS BENZENE SOLUBLES)
0.2 MG/M3 ACGIH TWA (AS BENZENE SOLUBLES)
ACGIH A1-CONFIRMED HUMAN CARCINOGEN.
0.1 MG/M3 NIOSH RECOMMENDED 10 HOUR TWA (CYCLOHEXANE-EXTRACTABLE FRACTION)

BENZO(A)PYRENE:
ACGIH A2-SUSPECTED HUMAN CARCINOGEN.

1 POUND CERCLA SECTION 103 REPORTABLE QUANTITY
SUBJECT TO CALIFORNIA PROPOSITION 65 CANCER AND/OR REPRODUCTIVE TOXICITY WARNING AND RELEASE REQUIREMENTS- (JULY 1, 1987)

PHYSICAL DATA

DESCRIPTION: YELLOW CRYSTALS WITH A FAINT AROMATIC ODOR.

BOILING POINT: 590-594 F (310-312 C) @ 10 MMHG

MELTING POINT: 349-351 F (176-177 C)

SPECIFIC GRAVITY: 1.35

SOLUBILITY IN WATER: INSOLUBLE

VAPOR PRESSURE: <1.0 MMHG @ 25 C

OTHER SOLVENTS (SOLVENT - SOLUBILITY):
BENZENE, TOLUENE, XYLENE; SPARINGLY SOLUBLE IN ALCOHOL 009613

FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD
SLIGHT FIRE HAZARD WHEN EXPOSED TO HEAT OR FLAME.

DUST-AIR MIXTURES MAY IGNITE OR EXPLODE.

FIREFIGHTING MEDIA:
DRY CHEMICAL, CARBON DIOXIDE, WATER SPRAY OR REGULAR FOAM (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

FOR LARGER FIRES, USE WATER SPRAY, FOG OR REGULAR FOAM (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

FIREFIGHTING:
MOVE CONTAINER FROM FIRE AREA IF YOU CAN DO IT WITHOUT RISK. DO NOT SCATTER SPILLED MATERIAL WITH HIGH-PRESSURE WATER STREAMS. DIKE FIRE-CONTROL WATER FOR LATER DISPOSAL (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5, GUIDE PAGE 31).

USE AGENTS SUITABLE FOR TYPE OF SURROUNDING FIRE. AVOID BREATHING HAZARDOUS VAPORS, KEEP UPWIND.

TOXICITY

BENZO(A)PYRENE:
IRRITATION DATA: 14 UG SKIN-MOUSE MILD.
TOXICITY DATA: 50 MG/KG SUBCUTANEOUS-RAT LD50; 500 MG/KG INTRAPERITONEAL-MOUSE LDLO; MUTAGENIC DATA (RTECS); REPRODUCTIVE EFFECTS DATA (RTECS); TUMORIGENIC DATA (RTECS).
CARCINOGEN STATUS: ANTICIPATED HUMAN CARCINOGEN (NTP); ANIMAL SUFFICIENT EVIDENCE (IARC GROUP-2A). BENZO(A)PYRENE, ADMINISTERED BY A NUMBER OF ROUTES, EXHIBITED A LOCAL AND SYSTEMIC CARCINOGENIC EFFECT IN ALL NINE SPECIES IN WHICH IT WAS TESTED. NO EPIDEMIOLOGICAL STUDIES ON THE SIGNIFICANCE OF BENZO(A)PYRENE EXPOSURE TO MAN ARE AVAILABLE, HOWEVER, COAL-TAR AND OTHER MATERIALS WHICH ARE KNOWN TO BE CARCINOGENIC TO MAN MAY CONTAIN BENZO(A)PYRENE.
ACUTE TOXICITY LEVEL: INSUFFICIENT DATA.
TARGET EFFECTS: POISONING MAY AFFECT THE LUNGS AND SKIN.*
AT INCREASED RISK FROM EXPOSURE: PERSONS WITH PRE-EXISTING SKIN DISORDERS.*
ADDITIONAL INFORMATION: MAY CROSS THE PLACENTA. MAY CAUSE IMMUNOSUPPRESSION.

* MAY BE BASED ON GENERAL COAL TAR PRODUCT INFORMATION.

HEALTH EFFECTS AND FIRST AID

009614

INHALATION:
BENZO(A)PYRENE:
CARCINOGEN.

ACUTE EXPOSURE- COAL TAR PRODUCT FUMES MAY CAUSE IRRITATION OF THE RESPIRATORY TRACT WITH COUGHING, SNEEZINAG, AND SWOLLEN NASAL MUCOSA AND SINUSES. MAY ALSO CAUSE GASTROINTESTINAL EFFECTS.

CHRONIC EXPOSURE- REPEATED EXPOSURE TO 9.5 MG/M3 AND 46.5 MG/M3 RESULTED IN TUMORS OF THE NASAL CAVITY, PHARYNX, LARYNX, AND TRACHEA IN HAMSTERS. PAPILLOMAS, PAPILLARY POLYPS, AND SQUAMOUS CELL CARCINOMAS IN THE ESOPHAGUS AND FORESTOMACH WERE ALSO OBSERVED FOLLOWING CHRONIC EXPOSURE TO 46.5 MG/M3. REPEATED AND PROLONGED EXPOSURE TO COAL TAR PRODUCTS MAY CAUSE CHRONIC BRONCHITIS, GUM DISEASE, AND INCREASED MORTALITY DUE TO LUNG CANCER.

FIRST AID- REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

SKIN CONTACT:
BENZO(A)PYRENE:
CARCINOGEN.

ACUTE EXPOSURE- MAY CAUSE IRRITATION. AN APPLICATION OF 120 UG CAUSED AN ALLERGIC CONTACT HYPERSENSITIVITY IN PREVIOUSLY EXPOSED MICE. A SINGLE APPLICATION OF 752 UG OF BENZO(A)PYRENE IN TOLUENE TO 13 MICE RESULTED IN PAPILLOMAS IN 2 ANIMALS AND A CARCINOMA IN ONE. BENZO(A)PYRENE MAY ALSO ACT AS AN INITIATOR. EXPOSURE TO COAL TAR PRODUCTS MAY CAUSE PHOTOTOXIC REACTIONS, ESPECIALLY IN AREAS EXPOSED TO SUN OR ULTRAVIOLET LIGHT. SYMPTOMS MAY INCLUDE ERYTHEMA, LOCAL DESQUAMATION, BURNING AND TINGLING SENSATIONS, ITCHING, EDEMA, PAPULAR DERMATITIS, AND THERMAL BURNS.

CHRONIC EXPOSURE- REPEATED DERMAL APPLICATIONS OF 1% BENZO(A)PYRENE TO HUMAN SKIN RESULTED IN REGRESSIVE VERRUCAE. NUCLEOLAR ENLARGEMENT WAS OBSERVED IN HUMAN VOLUNTEERS PAINTED DAILY FOR 4 CONSECUTIVE DAYS WITH BENZO(A)PYRENE. REPEATED APPLICATION OF BENZO(A)PYRENE IN A VARIETY OF SOLVENTS TO A NUMBER OF ANIMAL SPECIES RESULTED IN SKIN PAPILLOMAS AND CARCINOMAS. THE INCIDENCE OF BENIGN AND MALIGNANT TUMORS INCREASED AND THE LATENCY PERIOD DECREASED WITH HIGHER CONCENTRATIONS. REPEATED EXPOSURE TO SOME COAL TAR PRODUCTS MAY CAUSE PHOTOSENSITIVITY WITH HYPERMELANOSIS, CORNIFICATION OF SURFACE LAYERS, AND TELANGIOECTASIS. SEVERE CHRONIC PHOTODERMATITIS MAY RESULT IN LEUKODERMA.

FIRST AID- REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

EYE CONTACT:
BENZO(A)PYRENE:

ACUTE EXPOSURE- MAY CAUSE IRRITATION. EXPOSURE TO COAL TAR PRODUCT FUMES MAY CAUSE LACRIMATION, PHOTOPHOBIA, EDEMA OF THE EYELIDS, BURNING, A PURULENT DISCHARGE, AND CONJUNCTIVAL HYPEREMIA.

CHRONIC EXPOSURE- REPEATED AND PROLONGED EXPOSURE TO COAL TAR PRODUCT FUMES MAY CAUSE CONJUNCTIVITIS AND PTERGIA.

FIRST AID- WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

INGESTION:
BENZO(A)PYRENE:
CARCINOGEN.

ACUTE EXPOSURE- ACUTE INTRAGASTRIC ADMINISTRATION OF 50 OR 150 MG/KG RESULTED IN ENZYME ALTERATIONS IN THE MUCOSA OF THE GASTROINTESTINAL TRACT. A SINGLE DOSE OF 0.2 MG IN POLYETHYLENE GLYCOL TO MICE RESULTED IN 14 TUMORS IN 5 OUT OF 11 ANIMALS TESTED. A SINGLE ORAL DOSE OF 100 MG TO FEMALE RATS PRODUCED MAMMARY TUMORS IN 8 OF 9 ANIMALS.

CHRONIC EXPOSURE- REPEATED INGESTION OF 120 MG/KG PER DAY FOR 180 DAYS RESULTED IN DECREASED SURVIVAL TIME IN SOME STRAINS OF MICE. DEATH WAS CAUSED BY BONE MARROW DEPRESSION WITH APLASTIC ANEMIA AND PANYCTOPENIA, LEADING TO HEMORRHAGE OR INFECTION. MICE FED A DIET CONTAINING 250 PPM BENZO(A)PYRENE FOR 140 DAYS DEVELOPED LEUKEMIAS AND LUNG ADENOMAS IN ADDITION TO STOMACH TUMORS. RATS FED DAILY DOSES OF 2.5 MG DEVELOPED PAPILLOMAS IN THE ESOPHAGUS AND FORESTOMACH IN 3 OF 40 ANIMALS. BI-WEEKLY ADMINISTRATION OF 2-5 MG IN OIL TO HAMSTERS RESULTED IN PAPILLOMAS AND CARCINOMAS OF THE STOMACH, WITH THE INCIDENCE DEPENDENT UPON THE LENGTH OF ADMINISTRATION. HAMSTERS FED A DIET CONTAINING 500 PPM 4 DAYS PER WEEK FOR UP TO 14 MONTHS DEVELOPED TUMORS OF THE FORESTOMACH, ESOPHAGUS AND INTESTINE. EFFECTS ON FERTILITY AND EFFECTS ON THE EMBRYO OR FETUS HAVE BEEN REPORTED FOLLOWING CHRONIC INGESTION BY RODENTS. CHRONIC FEEDING OF COAL TAR PRODUCTS TO ANIMALS CAUSED LIVER AND LUNG DAMAGE AND DEATH.

FIRST AID- IF VICTIM IS CONSCIOUS, REMOVE INGESTED POISON BY GASTRIC LAVAGE, WITH ACTIVATED CHARCOAL AND A CUFFED ENDOTRACHEAL TUBE TO PREVENT ASPIRATION. IN THE ABSENCE OF DEPRESSION, CONVULSION OR IMPAIRED GAG REFLEX, IPECAC EMESIS CAN ALSO BE DONE WITHOUT INCREASING THE HAZARD OF ASPIRATION. WHEN VOMITING OCCURS, HOLD THE PATIENT WITH HEAD LOWER THAN HIPS TO HELP PREVENT PULMONARY ASPIRATION. AFTER VOMITING STOPS, GIVE 30 TO 60 ML OF FLEET'S PHOSPHO-SODA DILUTED 1:4 IN WATER. (DREISBACH, HANDBOOK OF POISONING, 11TH ED.).

ANTIDOTE:
NO SPECIFIC ANTIDOTE. TREAT SYMPTOMATICALLY AND SUPPORTIVELY.

REACTIVITY SECTION

REACTIVITY:
STABLE UNDER NORMAL TEMPERATURES AND PRESSURES.

INCOMPATIBILITIES:
BENZO(A)PYRENE:
OXIDIZERS (STRONG): FIRE AND EXPLOSION HAZARD.

DECOMPOSITION:
THERMAL DECOMPOSITION MAY RELEASE ACRID SMOKE AND IRRITATING FUMES.

POLYMERIZATION:
HAZARDOUS POLYMERIZATION HAS NOT BEEN REPORTED TO OCCUR UNDER NORMAL TEMPERATURES AND PRESSURES.

STORAGE-DISPOSAL

OBSERVE ALL FEDERAL, STATE AND LOCAL REGULATIONS WHEN STORING OR DISPOSING OF THIS SUBSTANCE. FOR ASSISTANCE, CONTACT THE DISTRICT DIRECTOR OF THE ENVIRONMENTAL PROTECTION AGENCY.

009616

DISPOSAL

DISPOSAL MUST BE IN ACCORDANCE WITH STANDARDS APPLICABLE TO GENERATORS OF HAZARDOUS WASTE, 40CFR 262. EPA HAZARDOUS WASTE NUMBER U022.

CONDITIONS TO AVOID

MAY BURN BUT DOES NOT IGNITE READILY. AVOID CONTACT WITH STRONG OXIDIZERS, EXCESSIVE HEAT, SPARKS, OR OPEN FLAME.

SPILLS AND LEAKS

SOIL-RELEASE:
DIG HOLDING AREA SUCH AS LAGOON, POND OR PIT FOR CONTAINMENT.

USE PROTECTIVE COVER SUCH AS A PLASTIC SHEET TO PREVENT MATERIAL FROM DISSOLVING IN FIRE EXTINGUISHING WATER OR RAIN.

WATER-SPILL:
USE ACTIVATED CARBON TO ABSORB SPILLED SUBSTANCE THAT IS DISSOLVED.

USE SUCTION HOSES TO REMOVE TRAPPED SPILL MATERIAL.

USE MECHANICAL DREDGES OR LIFTS TO EXTRACT IMMOBILIZED MASSES OF POLLUTION AND PRECIPITATES.

THE CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT OF 1986 (PROPOSITION 65) PROHIBITS CONTAMINATING ANY KNOWN SOURCE OF DRINKING WATER WITH SUBSTANCES KNOWN TO CAUSE CANCER AND/OR REPRODUCTIVE TOXICITY.

OCCUPATIONAL-SPILL:
SWEEP UP AND PLACE IN SUITABLE CLEAN, DRY CONTAINERS FOR RECLAMATION OR LATER DISPOSAL. DO NOT FLUSH SPILLED MATERIAL INTO SEWER. KEEP UNNECESSARY PEOPLE AWAY.

REPORTABLE QUANTITY (RQ): 1 POUND
THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) SECTION 304 REQUIRES THAT A RELEASE EQUAL TO OR GREATER THAN THE REPORTABLE QUANTITY FOR THIS SUBSTANCE BE IMMEDIATELY REPORTED TO THE LOCAL EMERGENCY PLANNING COMMITTEE AND THE STATE EMERGENCY RESPONSE COMMISSION (40 CFR 355.40). IF THE RELEASE OF THIS SUBSTANCE IS REPORTABLE UNDER CERCLA SECTION 103, THE NATIONAL RESPONSE CENTER MUST BE NOTIFIED IMMEDIATELY AT (800) 424-8802 OR (202) 426-2675 IN THE METROPOLITAN WASHINGTON, D.C. AREA (40 CFR 302.6).

PROTECTIVE EQUIPMENT SECTION

VENTILATION:
PROVIDE LOCAL EXHAUST OR PROCESS ENCLOSURE VENTILATION TO MEET PUBLISHED EXPOSURE LIMITS.

009617

RESPIRATOR:
THE FOLLOWING RESPIRATORS ARE RECOMMENDED BASED ON INFORMATION FOUND IN THE PHYSICAL DATA, TOXICITY AND HEALTH EFFECTS SECTIONS. THEY ARE RANKED IN ORDER FROM MINIMUM TO MAXIMUM RESPIRATORY PROTECTION.
THE SPECIFIC RESPIRATOR SELECTED MUST BE BASED ON CONTAMINATION LEVELS FOUND IN THE WORK PLACE, MUST BE BASED ON THE SPECIFIC OPERATION, MUST NOT EXCEED THE WORKING LIMITS OF THE RESPIRATOR AND MUST BE JOINTLY APPROVED BY THE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH AND THE MINE SAFETY AND HEALTH ADMINISTRATION (NIOSH-MSHA).

ANY TYPE 'C' SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE OR WITH A FULL FACEPIECE, HELMET OR HOOD OPERATED IN CONTINOUS-FLOW MODE.

ANY SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

FOR FIREFIGHTING AND OTHER IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONDITIONS:

ANY SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

ANY SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE AND OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE IN COMBINATION WITH AN AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

CLOTHING:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE (IMPERVIOUS) CLOTHING AND EQUIPMENT TO PREVENT ANY POSSIBILITY OF SKIN CONTACT WITH THIS SUBSTANCE.

GLOVES:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE GLOVES TO PREVENT CONTACT WITH THIS SUBSTANCE.

EYE PROTECTION:
EMPLOYEE MUST WEAR SPLASH-PROOF OR DUST-RESISTANT SAFETY GOGGLES AND A FACESHIELD TO PREVENT CONTACT WITH THIS SUBSTANCE.

EMERGENCY WASH FACILITIES:
WHERE THERE IS ANY POSSIBILITY THAT AN EMPLOYEE'S EYES AND/OR SKIN MAY BE EXPOSED TO THIS SUBSTANCE, THE EMPLOYER SHOULD PROVIDE AN EYE WASH FOUNTAIN AND QUICK DRENCH SHOWER WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

AUTHORIZED BY- OCCUPATIONAL HEALTH SERVICES, INC.

CREATION DATE: 03/18/85 REVISION DATE: 12/03/90

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MATERIAL SAFETY DATA SHEET OHS26420

009618

OCCUPATIONAL HEALTH SERVICES, INC.
11 WEST 42ND STREET, 12TH FLOOR
NEW YORK, NEW YORK 10036
1-800-445-MSDS (1-800-445-6737) OR 1-212-789-3535

FOR EMERGENCY SOURCE INFORMATIO
CONTACT: 1-615-366-2000

SUBSTANCE IDENTIFICATION

CAS-NUMBER 56-55-3
RTEC-NUMBER CV9275000

SUBSTANCE: 1,2-BENZANTHRACENE

TRADE NAMES/SYNONYMS:
BENZ(A)ANTHRACENE: 1,2-BENZOANTHRACENE: TETRAPHENE: BENZO(A)ANTHRACENE: 2,3-BENZOPHENANTHRENE: BENZANTHRENE: NAPHTHANTHRACENE: BENZOANTHRACENE: 1,2-BENZ(A)ANTHRACENE: BENZO(B)PHENANTHRENE: BENZANTHRACENE: U018: OHS26420

CHEMICAL FAMILY:
POLYNUCLEAR AROMATIC HYDROCARBON

MOLECULAR FORMULA: C18-H12 MOLECULAR WEIGHT: 228.29

CERCLA RATINGS (SCALE 0-3): HEALTH=3 FIRE=U REACTIVITY=0 PERSISTENCE=3
NFPA RATINGS (SCALE 0-4): HEALTH=3 FIRE=U REACTIVITY=0

COMPONENTS AND CONTAMINANTS

COMPONENT: 1,2-BENZANTHRACENE CAS# 56-55-3 PERCENT: 100

OTHER CONTAMINANTS: NONE

EXPOSURE LIMIT:
COAL TAR PITCH VOLATILES (POLYCYCLIC AROMATIC HYDROCARBONS):
0.2 MG/M3 OSHA TWA (AS BENZENE SOLUBLES)
0.2 MG/M3 ACGIH TWA (AS BENZENE SOLUBLES)
ACGIH A1-CONFIRMED HUMAN CARCINOGEN.
0.1 MG/M3 NIOSH RECOMMENDED 10 HOUR TWA (CYCLOHEXANE-EXTRACTABLE FRACTION)

1,2-BENZANTHRACENE:
10 POUNDS CERCLA SECTION 103 REPORTABLE QUANTITY
SUBJECT TO CALIFORNIA PROPOSITION 65 CANCER AND/OR REPRODUCTIVE TOXICITY WARNING AND RELEASE REQUIREMENTS- (JULY 1, 1987)

PHYSICAL DATA

DESCRIPTION: COLORLESS LEAFLETS OR PLATES WITH A GREENISH-YELLOW FLUORESCENCE

..ILING POINT: 815 F (435 C) SUBLIMESMELTING POINT: 324 F (162 C)

SPECIFIC GRAVITY: NOT AVAILABLE SOLUBILITY IN WATER: INSOLUBLE

OTHER SOLVENTS (SOLVENT - SOLUBILITY):
SOLUBLE IN DIETHYL ETHER, ACETONE, BENZENE, MOST

ORGANIC SOLVENTS; SLIGHTLY SOLUBLE IN ACETIC ACID, ALCOHOL; ALMOST INSOLUBLE IN BOILING ALCOHOL

009619

FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD
UNKNOWN FIRE AND EXPLOSION HAZARD.

FIREFIGHTING MEDIA:
DRY CHEMICAL, CARBON DIOXIDE, WATER SPRAY OR REGULAR FOAM (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

FOR LARGER FIRES, USE WATER SPRAY, FOG OR REGULAR FOAM (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

FIREFIGHTING:
MOVE CONTAINER FROM FIRE AREA IF YOU CAN DO IT WITHOUT RISK. DO NOT SCATTER SPILLED MATERIAL WITH HIGH-PRESSURE WATER STREAMS. DIKE FIRE-CONTROL WATER FOR LATER DISPOSAL (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5, GUIDE PAGE 31).

USE AGENTS SUITABLE FOR TYPE OF SURROUNDING FIRE. AVOID BREATHING HAZARDOUS VAPORS, KEEP UPWIND.

TOXICITY

1,2-BENZANTHRACENE:
TOXICITY DATA: 10 MG/KG INTRAVENOUS-MOUSE LDLO; MUTAGENIC DATA (RTECS); TUMORINGENIC DATA (RTECS).
CARCINOGEN STATUS: ANTICIPATED HUMAN CARCINOGEN (NTP); ANIMAL SUFFICIENT EVIDENCE (IARC GROUP-2A). GIVEN BY SEVERAL ROUTES OF ADMINISTRATION IT HAS PROVED TO BE CARCINOGENIC IN THE MOUSE. IT PRODUCED LIVER CANCERS AND LUNG NEOPLASMS FOLLOWING REPEATED ORAL ADMINISTRATION TO YOUNG MICE. 1,2-BENZANTHRACENE IS A COMPLETE CARCINOGEN FOR THE MOUSE SKIN AND IS ALSO AN INITIATOR OF SKIN CARCINOGENESIS IN MICE.
ACUTE TOXICITY LEVEL: INSUFFICIENT DATA.
TARGET EFFECTS: NO DATA AVAILABLE.

HEALTH EFFECTS AND FIRST AID

INHALATION:
1,2-BENZANTHRACENE:
ACUTE EXPOSURE- SYMPTOMS OF EXPOSURE MAY INCLUDE NAUSEA AND VOMITING.
CHRONIC EXPOSURE- NO DATA AVAILABLE.

FIRST AID- REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

009620

SKIN CONTACT:
1,2-BENZANTHRACENE:
CARCINOGEN.
  ACUTE EXPOSURE- MAY CAUSE SLIGHT IRRITATION.
  CHRONIC EXPOSURE- REPEATED APPLICATION RESULTED IN SKIN TUMORS IN MICE.

FIRST AID- REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

EYE CONTACT:
1,2-BENZANTHRACENE:
  ACUTE EXPOSURE- MAY CAUSE SLIGHT IRRITATION.
  CHRONIC EXPOSURE- NO DATA AVAILABLE.

FIRST AID- WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

INGESTION:
1,2-BENZANTHRACENE:
CARCINOGEN.
  ACUTE EXPOSURE- SYMPTOMS OF EXPOSURE MAY INCLUDE NAUSEA AND VOMITING.
  CHRONIC EXPOSURE- REPEATED ORAL ADMINISTRATION PRODUCED HEPATOMAS AND LUNG ADENOMAS IN YOUNG MICE.

FIRST AID- TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY. IF VOMITING OCCURS, KEEP HEAD LOWER THAN HIPS TO PREVENT ASPIRATION.

ANTIDOTE:
NO SPECIFIC ANTIDOTE. TREAT SYMPTOMATICALLY AND SUPPORTIVELY.

REACTIVITY SECTION

REACTIVITY:
STABLE UNDER NORMAL TEMPERATURES AND PRESSURES.

INCOMPATIBILITIES:
1,2-BENZANTHRACENE:
  OXIDIZERS (STRONG): FIRE AND EXPLOSION HAZARD.

DECOMPOSITION:
THERMAL DECOMPOSITION MAY RELEASE ACRID SMOKE AND IRRITATING FUMES.

POLYMERIZATION:
HAZARDOUS POLYMERIZATION HAS NOT BEEN REPORTED TO OCCUR UNDER NORMAL TEMPERATURES AND PRESSURES.

STORAGE-DISPOSAL

OBSERVE ALL FEDERAL, STATE AND LOCAL REGULATIONS WHEN STORING OR DISPOSING OF THIS SUBSTANCE. FOR ASSISTANCE, CONTACT THE DISTRICT DIRECTOR OF THE

ENVIRONMENTAL PROTECTION AGENCY.

009621

DISPOSAL

DISPOSAL MUST BE IN ACCORDANCE WITH STANDARDS APPLICABLE TO GENERATORS OF HAZARDOUS WASTE, 40CFR 262. EPA HAZARDOUS WASTE NUMBER U018.

CONDITIONS TO AVOID

MAY BURN BUT DOES NOT IGNITE READILY. AVOID CONTACT WITH STRONG OXIDIZERS, EXCESSIVE HEAT, SPARKS, OR OPEN FLAME.

SPILLS AND LEAKS

WATER-SPILL:
THE CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT OF 1986 (PROPOSITION 65) PROHIBITS CONTAMINATING ANY KNOWN SOURCE OF DRINKING WATER WITH SUBSTANCES KNOWN TO CAUSE CANCER AND/OR REPRODUCTIVE TOXICITY.

OCCUPATIONAL-SPILL:
SWEEP UP AND PLACE IN SUITABLE CLEAN, DRY CONTAINERS FOR RECLAMATION OR LATER DISPOSAL. DO NOT FLUSH SPILLED MATERIAL INTO SEWER. KEEP UNNECESSARY PEOPLE AWAY.

REPORTABLE QUANTITY (RQ): 10 POUNDS
THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) SECTION 304 REQUIRES THAT A RELEASE EQUAL TO OR GREATER THAN THE REPORTABLE QUANTITY FOR THIS SUBSTANCE BE IMMEDIATELY REPORTED TO THE LOCAL EMERGENCY PLANNING COMMITTEE AND THE STATE EMERGENCY RESPONSE COMMISSION (40 CFR 355.40). IF THE RELEASE OF THIS SUBSTANCE IS REPORTABLE UNDER CERCLA SECTION 103, THE NATIONAL RESPONSE CENTER MUST BE NOTIFIED IMMEDIATELY AT (800) 424-8802 OR (202) 426-2675 IN THE METROPOLITAN WASHINGTON, D.C. AREA (40 CFR 302.6).

PROTECTIVE EQUIPMENT SECTION

VENTILATION:
PROVIDE LOCAL EXHAUST OR PROCESS ENCLOSURE VENTILATION SYSTEM.

RESPIRATOR:
THE FOLLOWING RESPIRATORS ARE RECOMMENDED BASED ON INFORMATION FOUND IN THE PHYSICAL DATA, TOXICITY AND HEALTH EFFECTS SECTIONS. THEY ARE RANKED IN ORDER FROM MINIMUM TO MAXIMUM RESPIRATORY PROTECTION.
THE SPECIFIC RESPIRATOR SELECTED MUST BE BASED ON CONTAMINATION LEVELS FOUND IN THE WORK PLACE, MUST BE BASED ON THE SPECIFIC OPERATION, MUST NOT EXCEED THE WORKING LIMITS OF THE RESPIRATOR AND MUST BE JOINTLY APPROVED BY THE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH AND THE MINE SAFETY AND HEALTH ADMINISTRATION (NIOSH-MSHA).

ANY TYPE 'C' SUPPLIED-AIR RESPIRATOR WITH A FULL FACEPIECE OPERATED IN

PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE OR WITH A FULL FACEPIECE, HELMET OR HOOD OPERATED IN CONTINOUS-FLOW MODE.

ANY SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

009622

FOR FIREFIGHTING AND OTHER IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONDITIONS

ANY SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

ANY SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE AND OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE IN COMBINATION WITH AN AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

CLOTHING:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE (IMPERVIOUS) CLOTHING AND EQUIPMENT TO PREVENT REPEATED OR PROLONGED SKIN CONTACT WITH THIS SUBSTANCE.

GLOVES:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE GLOVES TO PREVENT CONTACT WITH THIS SUBSTANCE.

EYE PROTECTION:
EMPLOYEE MUST WEAR SPLASH-PROOF OR DUST-RESISTANT SAFETY GOGGLES TO PREVENT EYE CONTACT WITH THIS SUBSTANCE.

EMERGENCY EYE WASH: WHERE THERE IS ANY POSSIBILITY THAT AN EMPLOYEE'S EYES MAY BE EXPOSED TO THIS SUBSTANCE, THE EMPLOYER SHOULD PROVIDE AN EYE WASH FOUNTAIN WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

AUTHORIZED BY- OCCUPATIONAL HEALTH SERVICES, INC.

CREATION DATE: 09/01/87 REVISION DATE: 12/03/90

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MATERIAL SAFETY DATA SHEET OHS11330

OCCUPATIONAL HEALTH SERVICES, INC.
11 WEST 42ND STREET, 12TH FLOOR
NEW YORK, NEW YORK 10036
1-800-445-MSDS (1-800-445-6737) OR 1-212-789-3535

FOR EMERGENCY SOURCE INFORMATION
CONTACT: 1-615-366-2000

SUBSTANCE IDENTIFICATION

CAS-NUMBER 193-39-5
RTEC-NUMBER NK9300000

SUBSTANCE: INDENO(1,2,3-CD)PYRENE

TRADE NAMES/SYNONYMS:
IP: ORTHO-PHENYLENEPYRENE: 1,10-(ORTHO-PHENYLENE)PYRENE: 1,10-(1,2-PHENYLENE)PYRENE: 2,3-ORTHO-PHENYLENEPYRENE: 2,3-PHENYLENEPYRENE: RCRA U137: C22H12: OHS11330

CHEMICAL FAMILY:
AROMATIC

MOLECULAR FORMULA: C22-H12 MOLECULAR WEIGHT: 276.34

CERCLA RATINGS (SCALE 0-3): HEALTH=3 FIRE=0 REACTIVITY=0 PERSISTENCE=3
NFPA RATINGS (SCALE 0-4): HEALTH=3 FIRE=0 REACTIVITY=0

COMPONENTS AND CONTAMINANTS

COMPONENT: INDENO(1,2,3-CD)PYRENE CAS# 193-39-5 PERCENT: 100

OTHER CONTAMINANTS: NONE

EXPOSURE LIMIT:
COAL TAR PITCH VOLATILES (POLYCYCLIC AROMATIC HYDROCARBONS):
0.2 MG/M3 OSHA TWA (AS BENZENE SOLUBLES)
0.2 MG/M3 ACGIH TWA (AS BENZENE SOLUBLES)
ACGIH A1-CONFIRMED HUMAN CARCINOGEN.
0.1 MG/M3 NIOSH RECOMMENDED 10 HOUR TWA (CYCLOHEXANE-EXTRACTABLE FRACTION)

INDENO(1,2,3-CD)PYRENE:
100 POUNDS CERCLA SECTION 103 REPORTABLE QUANTITY
SUBJECT TO CALIFORNIA PROPOSITION 65 CANCER AND/OR REPRODUCTIVE TOXICITY WARNING AND RELEASE REQUIREMENTS- (JANUARY 1, 1988)

PHYSICAL DATA

DESCRIPTION: YELLOW PLATES OR NEEDLES WITH A GREENISH-YELLOW FLUORESCENCE.

MELTING POINT: 324.5-327 F (163.6 C) SOLUBILITY IN WATER: INSOLUBLE

OTHER SOLVENTS (SOLVENT - SOLUBILITY):
SOLUBLE IN ORGANIC SOLVENTS

FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD
NEGLIGIBLE FIRE HAZARD WHEN EXPOSED TO HEAT OR FLAME.

009624

FIREFIGHTING MEDIA:
DRY CHEMICAL, CARBON DIOXIDE, WATER SPRAY OR REGULAR FOAM (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

FOR LARGER FIRES, USE WATER SPRAY, FOG OR REGULAR FOAM (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

FIREFIGHTING:
NO ACUTE HAZARD. MOVE CONTAINER FROM FIRE AREA IF POSSIBLE. AVOID BREATHING VAPORS OR DUSTS; KEEP UPWIND.

TOXICITY

INDENO(1,2,3-CD)PYRENE:
TOXICITY DATA: MUTAGENIC DATA (RTECS); TUMORIGENIC DATA (RTECS).
CARCINOGEN STATUS: ANTICIPATED HUMAN CARCINOGEN (NTP); ANIMAL SUFFICIENT EVIDENCE (IARC GROUP-2B). INDENO(1,2,3-CD)PYRENE IS A COMPLETE CARCINOGEN AND AN INITIATOR FOR SKIN CARCINOGENESIS IN MICE. IT PRODUCED LOCAL SARCOMAS AFTER SUBCUTANEOUS INJECTION AS WELL AS SKIN APPLICATION.
ACUTE TOXICITY LEVEL: NO DATA AVAILABLE.
TARGET AFFECTS: NO DATA AVAILABLE.

HEALTH EFFECTS AND FIRST AID

INHALATION:
INDENO(1,2,3-CD)PYRENE:
ACUTE EXPOSURE- INHALATION OF DUST MAY IRRITATE THE RESPIRATORY TRACT.
CHRONIC EXPOSURE- NO DATA AVAILABLE.

FIRST AID- REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

SKIN CONTACT:
INDENO(1,2,3-CD)PYRENE:
CARCINOGEN.
ACUTE EXPOSURE- POLYCYCLIC AROMATIC HYDROCARBONS MAY CAUSE IRRITATION.
CHRONIC EXPOSURE- INDENO(1,2,3-CD)PYRENE DISSOLVED IN ACETONE AND PAINTED ON THE SKIN OF MICE AT CONCENTRATIONS GREATER THAN 0.05% PRODUCED SKIN TUMORS, WHICH APPEARED AFTER SEVERAL MONTHS.

FIRST AID- REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

EYE CONTACT:
INDENO(1,2,3-CD)PYRENE:
ACUTE EXPOSURE- CONTACT WITH DUST MAY CAUSE IRRITATION.
CHRONIC EXPOSURE- NO DATA AVAILABLE.

009625

FIRST AID- WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

INGESTION:
INDENO(1,2,3-CD)PYRENE:
ACUTE EXPOSURE- THE ACUTE TOXICITY OF POLYCYLIC AROMATIC HYDROCARBONS APPEARS TO BE LOW IN RATS AND MICE. AT HIGH ACUTE DOSES, POLYCYCLIC AROMATIC HYDROCARBONS ARE TOXIC TO MANY TISSUES, AND DEGENERATIVE CHANGES MAY BE OBSERVED IN THE KIDNEY AND LIVER; THE THYMUS AND SPLEEN ARE PARTICULARLY SENSITIVE TO THE ACUTE EFFECTS OF POLYCYCLIC AROMATIC HYDROCARBONS.
CHRONIC EXPOSURE- NO DATA AVAILABLE.

FIRST AID- TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY. IF VOMITING OCCURS, KEEP HEAD LOWER THAN HIPS TO PREVENT ASPIRATION.

ANTIDOTE:
NO [illegible]IFIC ANTIDOTE. TREAT SYMPTOMATICALLY AND SUPPORTIVELY.

REACTIVITY SECTION

REACTIVITY:
STABLE UNDER NORMAL TEMPERATURES AND PRESSURES.

INCOMPATIBILITIES:
INDENO(1,2,3-CD)PYRENE:
NO DATA AVAILABLE.

DECOMPOSITION:
THERMAL DECOMPOSITION MAY RELEASE ACRID SMOKE AND IRRITATING FUMES.

POLYMERIZATION:
HAZARDOUS POLYMERIZATION HAS NOT BEEN REPORTED TO OCCUR UNDER NORMAL TEMPERATURES AND PRESSURES.

STORAGE-DISPOSAL

OBSERVE ALL FEDERAL, STATE AND LOCAL REGULATIONS WHEN STORING OR DISPOSING OF THIS SUBSTANCE. FOR ASSISTANCE, CONTACT THE DISTRICT DIRECTOR OF THE ENVIRONMENTAL PROTECTION AGENCY.

DISPOSAL

DISPOSAL MUST BE IN ACCORDANCE WITH STANDARDS APPLICABLE TO GENERATORS OF HAZARDOUS WASTE, 40CFR 262. EPA HAZARDOUS WASTE NUMBER U137.

CONDITIONS TO AVOID

NONE REPORTED.

SPILLS AND LEAKS

WATER-SPILL:
THE CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT OF 1986 (PROPOSITION 65) PROHIBITS CONTAMINATING ANY KNOWN SOURCE OF DRINKING WATER WITH SUBSTANCES KNOWN TO CAUSE CANCER AND/OR REPRODUCTIVE TOXICITY.

OCCUPATIONAL-SPILL:
NO SPECIAL PRECAUTIONS INDICATED.

REPORTABLE QUANTITY (RQ): 100 POUNDS
THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) SECTION 304 REQUIRES THAT A RELEASE EQUAL TO OR GREATER THAN THE REPORTABLE QUANTITY FOR THIS SUBSTANCE BE IMMEDIATELY REPORTED TO THE LOCAL EMERGENCY PLANNING COMMITTEE AND THE STATE EMERGENCY RESPONSE COMMISSION (40 CFR 355.40). IF THE RELEASE OF THIS SUBSTANCE IS REPORTABLE UNDER CERCLA SECTION 103, THE NATIONAL RESPONSE CENTER MUST BE NOTIFIED IMMEDIATELY AT (800) 424-8802 OR (202) 426-2675 IN THE METROPOLITAN WASHINGTON, D.C. AREA (40 CFR 302.6).

PROTECTIVE EQUIPMENT SECTION

VENTILATION:
PROVIDE LOCAL EXHAUST OR PROCESS ENCLOSURE VENTILATION SYSTEM.

RESPIRATOR:
THE FOLLOWING RESPIRATORS AND MAXIMUM USE CONCENTRATIONS ARE RECOMMENDATIONS BY THE U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, NIOSH POCKET GUIDE TO CHEMICAL HAZARDS; NIOSH CRITERIA DOCUMENTS OR BY THE U.S. DEPARTMENT OF LABOR, 29 CFR 1910 SUBPART Z.
THE SPECIFIC RESPIRATOR SELECTED MUST BE BASED ON CONTAMINATION LEVELS FOUND IN THE WORK PLACE, MUST NOT EXCEED THE WORKING LIMITS OF THE RESPIRATOR AND BE JOINTLY APPROVED BY THE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH AND THE MINE SAFETY AND HEALTH ADMINISTRATION (NIOSH-MSHA).

COAL TAR PITCH VOLATILES (POLYCYCLIC AROMATIC HYDROCARBONS):

AT ANY DETECTABLE CONCENTRATION:

ANY SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.
ANY SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE IN COMBINATION WITH AN AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

ESCAPE- ANY AIR-PURIFYING FULL FACEPIECE RESPIRATOR (GAS MASK) WITH CHIN-STYLE OR FRONT- OR BACK-MOUNTED ORGANIC VAPOR CANISTER HAVING

A HIGH-EFFICIENCY PARTICULATE FILTER.
ANY APPROPRIATE ESCAPE-TYPE SELF-CONTAINED BREATHING APPARATUS.

FOR FIREFIGHTING AND OTHER IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONDITIONS: 009627

ANY SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

ANY SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE AND OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE IN COMBINATION WITH AN AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

CLOTHING:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE (IMPERVIOUS) CLOTHING AND EQUIPMENT TO PREVENT REPEATED OR PROLONGED SKIN CONTACT WITH THIS SUBSTANCE.

GLOVES:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE GLOVES TO PREVENT CONTACT WITH THIS SUBSTANCE.

EYE PROTECTION:
EMPLOYEE MUST WEAR SPLASH-PROOF OR DUST-RESISTANT SAFETY GOGGLES TO PREVENT EYE CONTACT WITH THIS SUBSTANCE.

EMERGENCY EYE WASH: WHERE THERE IS ANY POSSIBILITY THAT AN EMPLOYEE'S EYES MAY BE EXPOSED TO THIS SUBSTANCE, THE EMPLOYER SHOULD PROVIDE AN EYE WASH FOUNTAIN WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

AUTHORIZED BY- OCCUPATIONAL HEALTH SERVICES, INC.

CREATION DATE: 05/20/87 REVISION DATE: 12/03/90

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MATERIAL SAFETY DATA SHEET OHS06570

009628

OCCUPATIONAL HEALTH SERVICES, INC.
11 WEST 42ND STREET, 12TH FLOOR
NEW YORK, NEW YORK 10036
1-800-445-MSDS (1-800-445-6737) OR 1-212-789-3535

FOR EMERGENCY SOURCE INFORMATIO
CONTACT: 1-615-366-2000

SUBSTANCE IDENTIFICATION

CAS-NUMBER 53-70-3
RTEC-NUMBER HN2625000

SUBSTANCE: DIBENZ(A,H)ANTHRACENE

TRADE NAMES/SYNONYMS:
DIBENZO(A,H)ANTHRACENE: 1,2:5,6-DIBENZANTHRACENE: 1,2,5,6-DBA:
DB(A,H)A: RCRA U063: OHS06570

CHEMICAL FAMILY:
HYDROXYL, POLYNUCLEAR

MOLECULAR FORMULA: C22-H14 MOLECULAR WEIGHT: 278.36

CERCLA RATINGS (SCALE 0-3): HEALTH=3 FIRE=1 REACTIVITY=0 PERSISTENCE=3
NFPA RATINGS (SCALE 0-4): HEALTH=3 FIRE=1 REACTIVITY=0

COMPONENTS AND CONTAMINANTS

COMPONENT: DIBENZ(A,H)ANTHRACENE CAS# 53-70-3 PERCENT: 100

OTHER CONTAMINANTS: NONE

EXPOSURE LIMIT:
COAL TAR PITCH VOLATILES (POLYCYCLIC AROMATIC HYDROCARBONS):
0.2 MG/M3 OSHA TWA (AS BENZENE SOLUBLES)
0.2 MG/M3 ACGIH TWA (AS BENZENE SOLUBLES)
ACGIH A1-CONFIRMED HUMAN CARCINOGEN.
0.1 MG/M3 NIOSH RECOMMENDED 10 HOUR TWA (CYCLOHEXANE-EXTRACTABLE FRACTION)

DIBENZ(A,H)ANTHRACENE:
1 POUND CERCLA SECTION 103 REPORTABLE QUANTITY
SUBJECT TO CALIFORNIA PROPOSITION 65 CANCER AND/OR REPRODUCTIVE TOXICITY
WARNING AND RELEASE REQUIREMENTS- (JANUARY 1, 1988)

PHYSICAL DATA

DESCRIPTION: COLORLESS CRYSTALLINE SOLID.

MELTING POINT: 511 F (266 C) SUBLIM SPECIFIC GRAVITY: 1.3

SOLUBILITY IN WATER: INSOLUBLE

OTHER SOLVENTS (SOLVENT - SOLUBILITY):
ALCOHOL, BENZENE, PETROLEUM ETHER

FIRE AND EXPLOSION DATA

009629

FIRE AND EXPLOSION HAZARD
SLIGHT FIRE HAZARD WHEN EXPOSED TO HEAT OR FLAME.

FIREFIGHTING MEDIA:
DRY CHEMICAL, CARBON DIOXIDE, WATER SPRAY OR REGULAR FOAM (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

FOR LARGER FIRES, USE WATER SPRAY, FOG OR REGULAR FOAM (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5).

FIREFIGHTING:
MOVE CONTAINER FROM FIRE AREA IF YOU CAN DO IT WITHOUT RISK. DO NOT SCATTER SPILLED MATERIAL WITH HIGH-PRESSURE WATER STREAMS. DIKE FIRE-CONTROL WATER FOR LATER DISPOSAL (1990 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.5, GUIDE PAGE 31).

USE AGENTS SUITABLE FOR TYPE OF SURROUNDING FIRE. AVOID BREATHING HAZARDOUS VAPORS, KEEP UPWIND.

TOXICITY

DIBENZ(A,H)ANTHRACENE:
10 MG/KG INTRAVENOUS-MOUSE LDLO; MUTAGENIC DATA (RTECS); TUMORIGENIC DATA (RTECS).
CARCINOGEN STATUS: ANTICIPATED HUMAN CARCINOGEN (NTP). ANIMAL SUFFICIENT EVIDENCE (IARC GROUP-2A). DB(A,H)A HAS PRODUCED TUMORS BY DIFFERENT ROUTES OF ADMINISTRATION IN ANIMALS. UPON ORAL ADMINISTRATION, IT PRODUCED TUMORS OF THE FORESTOMACH IN THE MOUSE; INTRATRACHEAL ADMINISTRATION TO HAMSTERS PRODUCED LUNG TUMORS. IN SKIN PAINTING IN MICE IT APPEARED TO BE EQUALLY EFFECTIVE, AND INDUCED LOCAL SARCOMAS IN NEWBORNS (SCU-MUS).

DIBENZ(A,H)ANTHRACENE IS A COAL TAR PITCH VOLATILE THAT MAY IRRITATE THE EYES, SKIN, AND MUCOUS MEMBRANES, AND MAY CAUSE SKIN SENSITIZATION AND PHOTOSENSITIZATION.

HEALTH EFFECTS AND FIRST AID

INHALATION:
DIBENZ(A,H)ANTHRACENE:
IRRITANT.

ACUTE EXPOSURE- MAY CAUSE RESPIRATORY IRRITATION, COUGH, DYSPNEA, AND PULMONARY EDEMA.

CHRONIC EXPOSURE- REPEATED OR PROLONGED EXPOSURE MAY CAUSE BRONCHITIS. EXPOSURE IS ASSOCIATED WITH CANCERS OF THE LUNGS, BLADDER, KIDNEYS, AND AND GASTROINTESTINAL TRACT.

FIRST AID- REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION. KEEP PERSON WARM AND AT REST. TREAT SYMPTOMATICALLY AND SUPPORTIVELY. GET MEDICAL ATTENTION IMMEDIATELY.

009630

SKIN CONTACT:
DIBENZ(A,H)ANTHRACENE:
IRRITANT/SENSITIZER/CARCINOGEN.

ACUTE EXPOSURE- DELAYED EFFECTS ARE ERYTHEMA AND SWELLING, WHICH APPEARS A FEW HOURS AFTER EXPOSURE OF SKIN SURFACES TO ULTRAVIOLET LIGHT. HYPERMELANOSIS IS COMMON. INTENSE CONTACT HAS CAUSED ACNE AND/OR FOLLICULITIS. DESQUAMATION, PIGMENTATION, DERMATITIS, AND THERMAL BURNS HAVE ALSO OCCURRED. ALLERGIC DERMATITIS IS RARE.

CHRONIC EXPOSURE- LEUKODERMA AND SKIN CANCER HAVE OCCURRED.

FIRST AID- REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

EYE CONTACT:
DIBENZ(A,H)ANTHRACENE:
IRRITANT.

ACUTE EXPOSURE- DELAYED IRRITATION MAY OCCUR, WITH CONJUNCTIVAL ERYTHEMA, LACRIMATION, PALPEBRAL EDEMA, PHOTOPHOBIA, AND CORNEAL ULCERATION.

CHRONIC EXPOSURE- PROLONGED EXPOSURE MAY PRODUCE THE SAME EFFECTS AS ACUTE EXPOSURE.

FIRST AID- WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER OR NORMAL SALINE, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

INGESTION:
DIBENZ(A,H)ANTHRACENE:

ACUTE EXPOSURE- INGESTION MAY CAUSE DIZZINESS, NAUSEA AND VOMITING, WEAKNESS, HEADACHE, TIGHTNESS IN THE CHEST, AND STAGGERING. IF LARGER AMOUNTS HAVE BEEN INGESTED, THESE SYMPTOMS MAY PROGRESS TO VISUAL DISTURBANCES, TREMORS, SHALLOW AND RAPID RESPIRATION, CONVULSIONS AND COMA. VIOLENT EXCITEMENT OR DELIRIUM MAY PRECEDE UNCONSCIOUSNESS. KIDNEY OR LIVER DAMAGE MAY OCCUR.

CHRONIC EXPOSURE- HAS NOT BEEN REPORTED IN HUMANS.

FIRST AID- REMOVE CHEMICAL BY GASTRIC LAVAGE WITH ACTIVATED CHARCOAL AND A CUFFED ENDOTRACHEAL TUBE TO PREVENT ASPIRATION. IN THE ABSENCE DEPRESSION, CONVULSION, OR IMPAIRED GAG REFLEX , IPECAC EMESIS MAY BE DONE. WHEN VOMITING OCCURS, KEEP HEAD LOWER THAN HIPS TO HELP PREVENT ASPIRATION. AFTER VOMITING STOPS, GIVE 30-60 MILLILITERS OF FLEET'S PHOSPHO-SODA DILUTED 1:4 IN WATER. MAINTAIN AIRWAY, BLOOD PRESSURE AND RESPIRATION. GET MEDICAL ATTENTION. LAVAGE MUST BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL. (DRIESBACH, HANDBOOK OF POISONING, 11TH ED.)

ANTIDOTE:
NO SPECIFIC ANTIDOTE. TREAT SYMPTOMATICALLY AND SUPPORTIVELY.

REACTIVITY SECTION

REACTIVITY:
STABLE UNDER NORMAL TEMPERATURES AND PRESSURES.

INCOMPATIBILITIES:

DIBENZ(A,H)ANTHRACENE:
CONTACT WITH STRONG OXIDIZERS MAY CAUSE FIRES AND EXPLOSIONS.

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DECOMPOSITION:
THERMAL DECOMPOSITION MAY RELEASE ACRID SMOKE AND IRRITATING FUMES.

POLYMERIZATION:
HAZARDOUS POLYMERIZATION HAS NOT BEEN REPORTED TO OCCUR UNDER NORMAL TEMPERATURES AND PRESSURES.

STORAGE-DISPOSAL

OBSERVE ALL FEDERAL, STATE AND LOCAL REGULATIONS WHEN STORING OR DISPOSING OF THIS SUBSTANCE. FOR ASSISTANCE, CONTACT THE DISTRICT DIRECTOR OF THE ENVIRONMENTAL PROTECTION AGENCY.

STORAGE

STORE AWAY FROM INCOMPATIBLE SUBSTANCES.

DISPOSAL

DISPOSAL MUST BE IN ACCORDANCE WITH STANDARDS APPLICABLE TO GENERATORS OF HAZARDOUS WASTE, 40CFR 262. EPA HAZARDOUS WASTE NUMBER U063.

CONDITIONS TO AVOID

MAY BURN BUT DOES NOT IGNITE READILY. AVOID CONTACT WITH STRONG OXIDIZERS, EXCESSIVE HEAT, SPARKS, OR OPEN FLAME.

SPILLS AND LEAKS

SOIL-RELEASE:
DIG HOLDING AREA SUCH AS LAGOON, POND OR PIT FOR CONTAINMENT.

USE PROTECTIVE COVER SUCH AS A PLASTIC SHEET TO PREVENT MATERIAL FROM DISSOLVING IN FIRE EXTINGUISHING WATER OR RAIN.

WATER-SPILL:
USE ACTIVATED CARBON TO ABSORB SPILLED SUBSTANCE THAT IS DISSOLVED.

USE SUCTION HOSES TO REMOVE TRAPPED SPILL MATERIAL.

USE MECHANICAL DREDGES OR LIFTS TO EXTRACT IMMOBILIZED MASSES OF POLLUTION AND PRECIPITATES.

THE CALIFORNIA SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT OF 1986 (PROPOSITION 65) PROHIBITS CONTAMINATING ANY KNOWN SOURCE OF DRINKING WATER WITH SUBSTANCES KNOWN TO CAUSE CANCER AND/OR REPRODUCTIVE TOXICITY.

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OCCUPATIONAL-SPILL:
SWEEP UP AND PLACE IN SUITABLE CLEAN, DRY CONTAINERS FOR RECLAMATION OR LATER DISPOSAL. DO NOT FLUSH SPILLED MATERIAL INTO SEWER. KEEP UNNECESSARY PEOPLE AWAY.

REPORTABLE QUANTITY (RQ): 1 POUND
THE SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT (SARA) SECTION 304 REQUIRES THAT A RELEASE EQUAL TO OR GREATER THAN THE REPORTABLE QUANTITY FOR THIS SUBSTANCE BE IMMEDIATELY REPORTED TO THE LOCAL EMERGENCY PLANNING COMMITTEE AND THE STATE EMERGENCY RESPONSE COMMISSION (40 CFR 355.40). IF THE RELEASE OF THIS SUBSTANCE IS REPORTABLE UNDER CERCLA SECTION 103, THE NATIONAL RESPONSE CENTER MUST BE NOTIFIED IMMEDIATELY AT (800) 424-8802 OR (202) 426-2675 IN THE METROPOLITAN WASHINGTON, D.C. AREA (40 CFR 302.6).

PROTECTIVE EQUIPMENT SECTION

VENTILATION:
PROVIDE LOCAL EXHAUST OR PROCESS ENCLOSURE VENTILATION TO MEET PUBLISHED EXPOSURE LIMITS.

RESPIRATOR:
THE FOLLOWING RESPIRATORS AND MAXIMUM USE CONCENTRATIONS ARE RECOMMENDATIONS BY THE U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, NIOSH POCKET GUIDE TO CHEMICAL HAZARDS; NIOSH CRITERIA DOCUMENTS OR BY THE U.S. DEPARTMENT OF LABOR, 29 CFR 1910 SUBPART Z.
THE SPECIFIC RESPIRATOR SELECTED MUST BE BASED ON CONTAMINATION LEVELS FOUND IN THE WORK PLACE, MUST NOT EXCEED THE WORKING LIMITS OF THE RESPIRATOR AND BE JOINTLY APPROVED BY THE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH AND THE MINE SAFETY AND HEALTH ADMINISTRATION (NIOSH-MSHA).

COAL TAR PITCH VOLATILES (POLYCYCLIC AROMATIC HYDROCARBONS):

AT ANY DETECTABLE CONCENTRATION:

ANY SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.
ANY SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE IN COMBINATION WITH AN AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

ESCAPE- ANY AIR-PURIFYING FULL FACEPIECE RESPIRATOR (GAS MASK) WITH CHIN-STYLE OR FRONT- OR BACK-MOUNTED ORGANIC VAPOR CANISTER HAVING A HIGH-EFFICIENCY PARTICULATE FILTER.
ANY APPROPRIATE ESCAPE-TYPE SELF-CONTAINED BREATHING APPARATUS.

FOR FIREFIGHTING AND OTHER IMMEDIATELY DANGEROUS TO LIFE OR HEALTH CONDITIONS:

ANY SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

ANY SUPPLIED-AIR RESPIRATOR WITH FULL FACEPIECE AND OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE IN COMBINATION WITH AN AUXILIARY SELF-CONTAINED BREATHING APPARATUS OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE PRESSURE MODE.

CLOTHING:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE (IMPERVIOUS) CLOTHING AND EQUIPMENT TO PREVENT ANY POSSIBILITY OF SKIN CONTACT WITH THIS SUBSTANCE. 009633

GLOVES:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE GLOVES TO PREVENT CONTACT WITH THIS SUBSTANCE.

EYE PROTECTION:
EMPLOYEE MUST WEAR SPLASH-PROOF OR DUST-RESISTANT SAFETY GOGGLES AND A FACESHIELD TO PREVENT CONTACT WITH THIS SUBSTANCE.

EMERGENCY WASH FACILITIES:
WHERE THERE IS ANY POSSIBILITY THAT AN EMPLOYEE'S EYES AND/OR SKIN MAY BE EXPOSED TO THIS SUBSTANCE, THE EMPLOYER SHOULD PROVIDE AN EYE WASH FOUNTAIN AND QUICK DRENCH SHOWER WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

AUTHORIZED BY- OCCUPATIONAL HEALTH SERVICES, INC.

CREATION DATE: 03/18/85 REVISION DATE: 12/03/90

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009634

COAL TAR PITCH VOLATILES

CAS: 8007-45-2

TLV-TWA, 0.2 mg/m³, as Benzene Soluble Fraction
Appendix A1a — Recognized Human Carcinogen

The pitch of coal tar is the black or dark brown amorphous residue that remains after the redistillation process. The volatiles contain a large quantity of lower molecular weight polycyclic hydrocarbons.[1-3] As these hydrocarbons (naphthalene, fluorene, anthracene, acridine, phenanthrene) sublime into the air and there is an increase of benzo(a)pyrene (BaP or 3,4-benzpyrene) and other higher weight polycyclic hydrocarbons in the tar and in the fumes. Polycyclic hydrocarbons, known to be carcinogenic, are of this large molecular type.

Coal tar is used as a base for coatings and paints, for roofing and paving, and as a binder for carbon electrodes.

Doll[4] found that deaths from cancer of the lungs and pleura of retired gas-workers is approximately two times the expected rate.

Coal tar pitch polluted air is characterized by large amounts of phenanthrene, anthracene, pyrene, and carbazole. Coal tar pitch contains approximately 10% polycyclic hydrocarbons, and three different samples analyzed by Sawicki et al.[1] gave a concentration of 1.4% BaP alone.

Samples collected in urban and nonurban sites[5,6] contained a range of 2.4-410 μg BaP/g of particulate (38-2600 μg BaP/g of benzene fraction or 0.11-61 μg/1000 m³ of air) in the former locations and 0.15-51 μg BaP/g of particulate (9.3-730 μg BaP/g of benzene soluble fraction or 0.01-1.9 μg BaP/1000 m³ of air) in the latter[5] during a three-month period, January through March.

Falk et al[7-10] pointed out that the amount of BaP in the air was greater than one would expect on the basis of comparative quantitative emissions of other hydrocarbons. The composition of the hydrocarbons varies with time and distance, suggesting differences in stability of the compounds. The authors conclude that chrysene, 1,12-benzperylene, coronene, and BaP are stable, and phenanthrene, an "unidentified hydrocarbon" and anthranthrene are most readily destroyed, usually within 48 hours. Intermediate stability is demonstrated by pyrene (58% recovery in 48 hours) and fluoranthrene (80% recovery in 48 hours).

Stability of polycyclic hydrocarbons was also studied by Commins and Lawther.[11] They point out that the temperature applied to sinter the filter used to collect the sample altered the apparent stability for BaP. They concluded that the filter should never be subjected to temperatures above 100°C; no loss of BaP was found after heating 100 μg BaP on a sintered disc in a sealed tube at 100°C for seven hours.

In further experiments, Kotin et al[9] painted the interscapular area of C57 black mice three times weekly with benzene extracts of natural smog. First tumors appeared 465 days following the initial application.

Fairhall[12] stated that fumes of dust from native asphalt do not present a substantial health hazard in comparison with coal tar fume or dust, citing the work of Hueper[13] and Davies.[14] Hueper[15] also pointed out that, as a rule, a minimal time of exposure of one to five years is required to develop occupational cancer. Similarly, occupational cancers often develop many years after exposure to carcinogens has ceased. Simmers[16] concluded that the degree of change noted in the lungs of rats breathing air contaminated with aromatic polycyclic hydrocarbons is dose-dependent.

In its criteria document for coal tar products, NIOSH cites papers dealing primarily with coke oven and aluminum potroom workers.[17] A study of aluminum industry potroom workers[18] showed an increase in lung cancer mortality. A paper on this industry in the Soviet Union associates such an increase with concentrations of tarry substances between 27 and 2130 mg/m³, while the BaP levels were between 0.6 and 56 μg/m³.[19] High respiratory mortality among coke oven workers in Great Britain was reported.[20] Kidney as well as lung cancer was relatively prevalent among American coke-oven workers exposed 5 years or more.[21]

Animal studies indicating that lung and kidney tumors were caused by exposure to coal tar aerosols were also cited.

The occupational exposure standard recommended by NIOSH was 0.1 mg/m³ for the cyclohexane extractable fraction.[17] A 1977 summary, however, gives 0.2 mg/m³ as the NIOSH recommendation for coal tar pitch volatiles.[22]

In the absence of more definitive information on the identity of the components of coal tar pitch aerosols responsible for carcinogenic effects, a TLV based on the benzene (or other suitable solvent) soluble fraction appears to be the most practical compromise. If the concentration of aerosols from coal tar, on this basis, is maintained below 0.2 mg/m³, any increase in the incidence of lung and other tumors, due to occupational exposure, should be minimal.

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Occupational Health Guideline for Coal Tar Pitch Volatiles

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

Anthracene

- Formula: $C_{14}H_{10}$
- Synonyms: None
- Appearance and odor: Pale green solid with a faint aromatic odor.

Phenanthrene

- Formula: $C_{14}H_{10}$
- Synonyms: None
- Appearance and odor: Colorless solid with a faint aromatic odor.

Pyrene

- Formula: $C_{16}H_{10}$
- Synonyms: None
- Appearance: Bright yellow solid

Carbazole

- Formula: $C_{12}H_{9}N$
- Synonyms: None
- Appearance and odor: Colorless solid with a faint aromatic odor.

Benzo(a)pyrene

- Formula: $C_{20}H_{12}$
- Synonyms: BaP, 3,4-benzopyrene
- Appearance and odor: Colorless solid with a faint aromatic odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for coal tar pitch volatiles is 0.2 milligram of coal tar pitch volatiles per cubic meter of air (mg/m^3) averaged over an eight-hour work shift. NIOSH has recommended that the permissible exposure limit for coal tar products be reduced to 0.1 mg/m^3 (cyclohexane-extractable fraction) averaged over a work shift of up to 10 hours per day, 40 hours per week, and that coal tar products be regulated as occupational carcinogens. The NIOSH Criteria Document for Coal Tar Products and NIOSH Criteria Document for Coke Oven Emissions should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Coal tar pitch volatiles can affect the body if they are inhaled or if they come in contact with the eyes or skin.

- **Effects of overexposure**

Repeated exposure to coal tar pitch volatiles has been associated with an increased risk of developing bronchitis and cancer of the lungs, skin, bladder, and kidneys. Pregnant women may be especially susceptible to exposure effects associated with coal tar pitch volatiles. Repeated exposure to these materials may also cause sunlight to have a more severe effect on a person's skin. In addition, this type of exposure may cause an allergic skin rash.

- **Reporting signs and symptoms**

A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to coal tar pitch volatiles.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to coal tar pitch volatiles at potentially hazardous levels:

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

September 1978

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the oral cavity, respiratory tract, bladder, and kidneys should be stressed. The skin should be examined for evidence of chronic disorders, for premalignant and malignant lesions, and evidence of hyperpigmentation or photosensitivity.

—Urinalysis: Coal tar pitch volatiles are associated with an excess of kidney and bladder cancer. A urinalysis should be obtained to include at a minimum specific gravity, albumin, glucose, and a microscopic on centrifuged sediment, as well as a test for red blood cells.

—Urinary cytology: Coal tar pitch volatiles are associated with an excess of kidney and bladder cancer. Employees having 5 or more years of exposure or who are 45 years of age or older should have a urinary cytology examination.

—Sputum cytology: Coal tar pitch volatiles are associated with an excess of lung cancer. Employees having 10 or more years of exposure or who are 45 years of age or older should have a sputum cytology examination.

—14" x 17" chest roentgenogram: Coal tar pitch volatiles are associated with an excess of lung cancer. Surveillance of the lungs is indicated.

—FVC and FEV (1 sec): Coal tar pitch volatiles are reported to cause an excess of bronchitis. Periodic surveillance is indicated.

—A complete blood count: Due to the possibility of benzene exposure associated with coal tar pitch volatiles, a complete blood count is considered necessary to search for leukemia and aplastic anemia.

—Skin disease: Coal tar pitch volatiles are defatting agents and can cause dermatitis on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of these agents.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis, and semi-annually for employees 45 years of age or older or with 10 or more years' exposure to coal tar pitch volatiles.

• **Summary of toxicology**

Coal tar pitch volatiles (CTPV) are products of the destructive distillation of bituminous coal and contain polynuclear aromatic hydrocarbons (PNA's). These hydrocarbons sublime readily, thereby increasing the amounts of carcinogenic compounds in working areas. Epidemiologic evidence suggests that workers intimately exposed to the products of combustion or distillation of bituminous coal are at increased risk of cancer at many sites. These include cancer of the respiratory tract, kidney, bladder, and skin. In a study of coke oven workers, the level of exposure to CTPV and the length of time exposed were related to the development of cancer. Coke oven workers with the highest risk of cancer were those employed exclusively at topside jobs for 5 or more years, for whom the increased risk of dying from lung cancer was 10-fold; all coke oven workers had a 7-½-fold increase in risk of dying from kidney cancer. Although the causative agent or agents of the cancer in coke oven workers is unidentified, it is suspected that several PNA's in the CTPV generated during the coking process are involved. Certain industrial populations exposed to coal tar products have a demonstrated risk of skin cancer. Substances containing PNA's which may produce skin cancer also produce contact dermatitis; examples are coal tar, pitch, and cutting oils. Although allergic dermatitis is readily induced by PNA's in guinea pigs, it is only rarely reported in humans from occupational contact with PNA's; these have resulted largely from the therapeutic use of coal tar preparations. Components of pitch and coal tar produce cutaneous photosensitization; skin eruptions are usually limited to areas exposed to the sun or ultraviolet light. Most of the phototoxic agents will induce hypermelanosis of the skin; if chronic photodermatitis is severe and prolonged, leukoderma may occur. Some oils containing PNA's have been associated with changes of follicular and sebaceous glands which commonly take the form of acne. There is evidence that exposures to emissions at coke ovens and gas retorts may be associated with an increased occurrence of chronic bronchitis. Coal tar pitch volatiles may be associated with benzene, an agent suspected of causing leukemia and known to cause aplastic anemia.

CHEMICAL AND PHYSICAL PROPERTIES

• **Physical data—Anthracene**

1. Molecular weight: 178.2
2. Boiling point (760 mm Hg): 340 C (644 F)
3. Specific gravity (water = 1): 1.24
4. Vapor density (air = 1 at boiling point of anthracene): 6.15
5. Melting point: 217 C (423 F)
6. Vapor pressure at 20 C (68 F): Less than 1 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble
8. Evaporation rate (butyl acetate = 1): Not applicable

• **Physical data—Phenanthrene**

1. Molecular weight: 178.2
2. Boiling point (760 mm Hg): 340 C (644 F)
3. Specific gravity (water = 1): 1.18
4. Vapor density (air = 1 at boiling point of phenanthrene): 6.15
5. Melting point: 100.5 C (213 F)
6. Vapor pressure at 20 C (68 F): Less than 1 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble
8. Evaporation rate (butyl acetate = 1): Not applicable

• **Physical data—Pyrene**

1. Molecular weight: 202.3
2. Boiling point (760 mm Hg): Greater than 360 C (greater than 680 F)

3. Specific gravity (water = 1): 1.28

4. Vapor density (air = 1 at boiling point of pyrene): 6.9

5. Melting point: 150.4 C (303 F)

6. Vapor pressure at 20 C (68 F): Less than 1 mm Hg

7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble

8. Evaporation rate (butyl acetate = 1): Not applicable

• **Physical data—Carbazole**

1. Molecular weight: 167.2

2. Boiling point (760 mm Hg): 355 C (671 F)

3. Specific gravity (water = 1): Greater than 1

4. Vapor density (air = 1 at boiling point of carbazole): 5.8

5. Melting point: 246 C (475 F)

6. Vapor pressure at 20 C (68 F): Less than 1 mm Hg

7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble

8. Evaporation rate (butyl acetate = 1): Not applicable

• **Physical data—Benzo(a)pyrene**

1. Molecular weight: 252.3

2. Boiling point (760 mm Hg): Greater than 360 C (greater than 680 F)

3. Specific gravity (water = 1): Greater than 1

4. Vapor density (air = 1 at boiling point of benzo(a)pyrene): 8.7

5. Melting point: 179 C (354 F)

6. Vapor pressure at 20 C (68 F): Less than 1 mm Hg

7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble

8. Evaporation rate (butyl acetate = 1): Not applicable

• **Reactivity**

1. Conditions contributing to instability: None hazardous

2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.

3. Hazardous decomposition products: None

4. Special precautions: None

• **Flammability**

1. Flash point: Anthracene: 121 C (250 F) (closed cup); Others: Data not available

2. Autoignition temperature: Anthracene: 540 C (1004 F); Others: Data not available

3. Flammable limits in air, % by volume: Anthracene: Lower: 0.6; Others: Data not available

4. Extinguishant: Foam, dry chemical, and carbon dioxide

• **Warning properties**

Grant states that "coal tar and its various crude fractions appear principally to cause reddening and squamous eczema of the lid margins, with only small erosions of the corneal epithelium and superficial changes in the stroma, which disappear in a month following exposure. Chronic exposure of workmen to tar fumes and dust has been reported to cause conjunctivitis and discoloration of the cornea in the palpebral fissure, either near the limbus or, in extreme cases, across the whole cornea. Occasionally, epithelioma of the lid margin has been attributed to contact with coal tar."

MONITORING AND MEASUREMENT PROCEDURES

• **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• **Method**

Coal tar products may be sampled by collection on a glass fiber filter with subsequent ultrasonic extraction and weighing. An analytical method for coal tar pitch volatiles is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 1, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00267-3).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent skin contact with condensed coal tar pitch volatiles, where skin contact may occur.

• If employees' clothing may have become contaminated with coal tar pitch volatiles, employees should change into uncontaminated clothing before leaving the work premises.

• Clothing contaminated with coal tar pitch volatiles should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of coal tar pitch volatiles from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the coal tar pitch volatiles, the person performing the operation should be informed of coal tar pitch volatiles's hazardous properties.

• Employees should be provided with and required to use splash-proof safety goggles where condensed coal tar pitch volatiles may contact the eyes.

SANITATION

• Workers subject to skin contact with coal tar pitch volatiles should wash with soap or mild detergent and water any areas of the body which may have contacted coal tar pitch volatiles at the end of each work day.

• Employees who handle coal tar pitch volatiles should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

• Areas in which exposure to coal tar pitch volatiles may occur should be identified by signs or other appropriate means, and access to these areas should be limited to authorized persons.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to coal tar pitch volatiles may occur and control methods which may be effective in each case:

Operation	Controls
Liberation from extraction and packaging from coal tar fraction of coking	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment
Use as a binding agent in manufacture of coal briquettes used for fuel; use as a dielectric in the manufacture of battery electrodes, electric-arc furnace electrodes, and electrodes for alumina reduction	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in manufacture of roofing felts and papers and roofing	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment
Use for protective coatings for pipes for underground conduits and drainage; use as a coating on concrete as waterproofing and corrosion-resistant material; use in road paving and sealing	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in manufacture and repair of refractory brick; use in production of foundry cores; use in manufacture of carbon ceramic items	Process enclosure; local exhaust ventilation; general dilution ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• **Eye Exposure**

If condensed coal tar pitch volatiles get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with these chemicals.

• **Skin Exposure**

If condensed coal tar pitch volatiles get on the skin, wash the contaminated skin using soap or mild detergent and water. Be sure to wash the hands before eating or smoking and to wash thoroughly at the close of work.

• **Breathing**

If a person breathes in large amounts of coal tar pitch volatiles, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of releases until cleanup has been completed.

• If coal tar pitch volatiles are released in hazardous concentrations, the following steps should be taken:

1. Ventilate area of spill.

2. Collect released material in the most convenient and safe manner for reclamation or for disposal in sealed containers in a secured sanitary landfill.

• Waste disposal method:
Coal tar pitch volatiles may be disposed of in sealed containers in a secured sanitary landfill.

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RESPIRATORY PROTECTION FOR COAL TAR PITCH VOLATILES

Condition	Minimum Respiratory Protection* Required Above 0.2 mg/m³
Particulate and Vapor Concentration	
2 mg/m³ or less	A chemical cartridge respirator with an organic vapor cartridge(s) and with a fume or high-efficiency filter. Any supplied-air respirator. Any self-contained breathing apparatus.
10 mg/m³ or less	A chemical cartridge respirator with a full facepiece and an organic vapor cartridge(s) and with a fume or high-efficiency filter. A gas mask with a chin-style or a front- or back-mounted organic vapor canister and with a full facepiece and a fume or high-efficiency filter. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
200 mg/m³ or less	A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode. A powered air-purifying respirator with an organic vapor cartridge and a high-efficiency particulate filter.
400 mg/m³ or less	A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode.
Greater than 400 mg/m³ or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against organic vapors and particulates, including pesticide respirators which meet the requirements of this class. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.

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Occupational Health Guideline for Naphthalene

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: $C_{10}H_8$
- Synonyms: White tar; naphthalin
- Appearance and odor: Colorless to brown solid with the odor of mothballs.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for naphthalene is 10 parts of naphthalene per million parts of air (ppm) averaged over an eight-hour work shift. This may also be expressed as 50 milligrams of naphthalene per cubic meter of air (mg/m^3).

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Naphthalene can affect the body if it is inhaled, if it comes in contact with the eyes or skin, or if it is swallowed. It may enter the body through the skin.

- **Effects of overexposure**

1. Short-term Exposure: Inhalation or ingestion of naphthalene may cause abdominal cramps, nausea, vomiting, diarrhea, headache, tiredness, confusion, painful urination, and bloody or dark urine. Swallowing large amounts may cause convulsions or coma. Inhalation, ingestion, and possibly skin absorption of naphthalene may cause destruction of red blood cells with anemia, fever, yellow jaundice, bloody urine, kidney and liver damage. Naphthalene, on contact with the eyes, has produced irritation. Naphthalene, on contact with the skin, has produced skin irritation.

2. Long-term Exposure: Repeated skin exposure to naphthalene may cause an allergic rash. Repeated exposure may cause cataracts.

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to naphthalene.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to naphthalene at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Persons with a deficiency of glucose-6-phosphate dehydrogenase in erythrocytes may be at increased risk from exposure. Examination of the eyes, blood, liver and kidneys should be stressed. The skin should be examined for evidence of chronic disorders.

—A complete blood count: Naphthalene has been shown to cause red blood cell hemolysis. A complete blood count should be performed, including a red cell count, a white cell count, and a differential count of a stained smear, as well as hemoglobin and hematocrit.

—Urinalysis: Since kidney damage may also occur from exposure to naphthalene, a urinalysis should be performed, including at a minimum specific gravity, albumin, glucose, and a microscopic on centrifuged sediment.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis.

- **Summary of toxicology**

Naphthalene vapor causes hemolysis and eye irritation; it may cause cataracts. Severe intoxication from ingestion of the solid results in characteristic manifestations of marked intravascular hemolysis and its consequences, including potentially fatal hyperkalemia. Initial symptoms include eye irritation, headache, confu-

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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sion, excitement, malaise, profuse sweating, nausea, vomiting, abdominal pain, and irritation of the bladder; there may be progression to jaundice, hematuria, hemoglobinuria, renal tubular blockage, and acute renal shutdown. Hematologic features include red cell fragmentation, icterus, severe anemia with nucleated red cells, leukocytosis, and dramatic decreases in hemoglobin, hematocrit, and red cell count; sometimes there is formation of Heinz bodies and methemoglobin. Individuals with a deficiency of glucose-6-phosphate dehydrogenase in erythrocytes may be more susceptible to hemolysis by naphthalene. Cataracts and ocular irritation have been produced experimentally in animals and have been described in humans; of 21 workers exposed to high concentrations of fume or vapor for 5 years, 8 had peripheral lens opacities; in other studies no abnormalities of the eyes have been detected in workers exposed to naphthalene for several years. The vapor causes eye irritation at 15 ppm; eye contact with the solid may result in conjunctivitis, superficial injury to the cornea, chorioretinitis, scotoma, and diminished visual acuity. Naphthalene on the skin may cause hypersensitivity dermatitis; chronic dermatitis is rare.

CHEMICAL AND PHYSICAL PROPERTIES

• **Physical data**

1. Molecular weight: 128.2
2. Boiling point (760 mm Hg): 218 C (424 F)
3. Specific gravity (water = 1): 1.14
4. Vapor density (air = 1 at boiling point of naphthalene): 4.4
5. Melting point: 74 – 80 C (165 – 176 F)
6. Vapor pressure at 20 C (68 F): 0.05 mm Hg
7. Solubility in water, g/100 g water at 20 C (68 F): 0.003
8. Evaporation rate (butyl acetate = 1): Much less than 1

• **Reactivity**

1. Conditions contributing to instability: None.
2. Incompatibilities: Contact with strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: Toxic gases and vapors (such as dense acrid smoke and carbon monoxide) may be released in a fire involving naphthalene.
4. Special precautions: Melted naphthalene will attack some forms of plastics, rubber, and coatings.

• **Flammability**

1. Flash point: 79 C (174 F) (closed cup)
2. Autoignition temperature: 526 C (979 F)
3. Flammable limits in air, % by volume: Lower: 0.9; Upper: 5.9
4. Extinguishant: Carbon dioxide, dry chemical, foam

• **Warning properties**

1. Odor Threshold: The AIHA *Hygienic Guide* reports that the odor threshold of naphthalene is "at least as low as 0.3 ppm."
2. Eye Irritation Level: The *Hygienic Guide* states that "naphthalene vapor is reported to cause eye irritation at 15 ppm or above in air."
3. Evaluation of Warning Properties: Through its odor and irritant effects, naphthalene can be detected at or below the permissible exposure limit. Naphthalene, therefore, is treated as a material with good warning properties.

MONITORING AND MEASUREMENT PROCEDURES

• **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• **Method**

Sampling and analyses may be performed by collection of vapors using an adsorption tube with subsequent desorption with carbon disulfide and gas chromatographic analysis. Also, detector tubes certified by NIOSH under 42 CFR Part 84 or other direct-reading devices calibrated to measure naphthalene may be used. An analytical method for naphthalene is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 4, 1978, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00317-3).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with naphthalene or liquids containing naphthalene.

• If employees' clothing may have become contaminated with solid naphthalene, employees should change into uncontaminated clothing before leaving the work premises.

• Clothing contaminated with naphthalene should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of naphthalene from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the naphthalene, the person performing the operation should be informed of naphthalene's hazardous properties.

• Non-impervious clothing which becomes contaminated with naphthalene should be removed promptly and not reworn until the naphthalene is removed from the clothing.

• Employees should be provided with and required to use dust- and splash-proof safety goggles where solid naphthalene or liquids containing naphthalene may contact the eyes.

SANITATION

• Skin that becomes contaminated with naphthalene should be promptly washed or showered with soap or mild detergent and water to remove any naphthalene.

• Eating and smoking should not be permitted in areas where solid naphthalene is handled, processed, or stored.

• Employees who handle naphthalene or liquids containing naphthalene should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to naphthalene may occur and control methods which may be effective in each case:

Operation	Controls
Formulation of insecticide and moth repellant as flakes, powder, balls, or cakes	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use as a fumigant for moth repellant and insecticide	General dilution ventilation; personal protective equipment
Use in manufacture of chemical intermediates for production of pharmaceuticals, resins, dyes, plasticizers, solvents, coatings, insecticides, pigments, rubber chemicals, tanning agents, surfactants, waxes, cable coatings, textile spinning lubricants, rodenticides, and in storage batteries	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Manufacture of naphthalene	Local exhaust ventilation; process enclosure; general dilution ventilation; personal protective equipment

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EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• **Eye Exposure**

If naphthalene or liquids containing naphthalene get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with this chemical.

• **Skin Exposure**

If molten naphthalene gets on the skin, immediately flush the skin with large amounts of water. Get medical attention immediately. If naphthalene or liquids containing naphthalene get on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If naphthalene or liquids containing naphthalene penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

• **Breathing**

If a person breathes in large amounts of naphthalene, move the exposed person to fresh air at once.

• **Swallowing**

When naphthalene has been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

• **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills until cleanup has been completed.

• If naphthalene is spilled, the following steps should be taken:

1. Ventilate area of spill.
2. For small quantities, sweep onto paper or other suitable material, place in an appropriate container and burn in a safe place (such as a fume hood). Large quantities may be reclaimed; however, if this is not practical, dissolve in a flammable solvent (such as alcohol) and atomize in a suitable combustion chamber.

• Waste disposal methods:

Naphthalene may be disposed of:

1. By making packages of naphthalene in paper or other flammable material and burning in a suitable combustion chamber.
2. By dissolving naphthalene in a flammable solvent (such as alcohol) and atomizing in a suitable combustion chamber.

ADDITIONAL INFORMATION

To find additional information on naphthalene, look up naphthalene in the following documents:

• Medical Surveillance for Chemical Hazards

• Respiratory Protection for Chemical Hazards

• Personal Protection and Sanitation for Chemical Hazards

These documents are available through the NIOSH Division of Technical Services, 4676 Columbia Parkway, Cincinnati, Ohio 45226.

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RESPIRATORY PROTECTION FOR NAPHTHALENE

Condition	Minimum Respiratory Protection* Required Above 10 ppm
Particulate and Vapor Concentration	
500 ppm or less	A chemical cartridge respirator with a full facepiece, organic vapor cartridge(s), and dust filter.
	A gas mask with a chin-style or a front- or back-mounted organic vapor canister and dust filter.
	Any supplied-air respirator with a full facepiece, helmet, or hood.
	Any self-contained breathing apparatus with a full facepiece.
Greater than 500 ppm or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
	A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	Any gas mask providing protection against organic vapors and particulates.
	Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.

Occupational Health Guideline for Chromium Metal and Insoluble Chromium Salts*

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

APPLICABILITY

The general guidelines contained in this document apply to all chromium metal and insoluble chromium salts. Physical and chemical properties of some specific compounds are provided for illustrative purposes.

SUBSTANCE IDENTIFICATION

Metallic chromium

- Formula: Cr
- Synonyms: None
- Appearance and odor: Shiny, odorless metal.

Copper chromite

- Formula: $Cu_2Cr_2O_4$
- Synonyms: Cuprous chromite
- Appearance and odor: Greenish-blue, odorless solid.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for chromium metal or insoluble chromium salts is 1 milligram of chromium metal or insoluble chromium salts per cubic meter of air (mg/m^3) averaged over an eight-hour work shift. Certain forms of chromium (VI) have been found to cause increased respiratory cancer among workers. Certain other forms of chromium (VI) are currently believed to be non-carcinogenic: The non-carcinogenic forms are the monochromates and bichromates (dichromates) of hydrogen, lithium, sodium, potassium, rubidium, cesium, and ammonium, and chromium (VI) oxide (chromium acid anhydride). NIOSH has not conducted an in-depth study of the toxicity of chromium metal or compounds containing chromium in an oxidation state other than 6. NIOSH recommends that the permissible exposure limit for carcinogenic chromium (VI) compounds be reduced to 0.001 Cr (VI) mg/m^3 and that these compounds be regulated as occupational carcinogens. NIOSH also recommends that the permissible exposure limit for non-carcinogenic chromium (VI) be reduced to 0.025 Cr (VI) mg/m^3 averaged over a work shift of up to 10 hours per day, 40 hours per week, with a ceiling level of 0.05 Cr (VI) mg/m^3 averaged over a 15-minute period. It is further recommended that chromium (VI) in the workplace be considered carcinogenic, unless it has been demonstrated that only the non-carcinogenic chromium (VI) compounds mentioned above are present. The NIOSH Criteria Documents for Chromic Acid and Chromium (VI) should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Chromium metal or insoluble chromium salts can affect the body if they are inhaled. They can also affect the body if they are swallowed.

- **Effects of overexposure**

Ferro chrome alloys have been associated with lung changes in workers exposed to these alloys. Chromite dust exposure may cause minor lung changes.

- **Reporting signs and symptoms**

A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to chromium metal or insoluble chromium salts.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to chromium metal or insoluble chromium salts at potentially hazardous levels:

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*These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the respiratory system should be stressed.

—14" x 17" chest roentgenogram: Chromium and its insoluble salts may cause human lung damage. Surveillance of the lungs is indicated.

—FVC and FEV (1 sec): Insoluble chromium salts are reported to cause decreased pulmonary function. Periodic surveillance is indicated.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis.

• **Summary of toxicology**

The dusts of chromium metal and its insoluble salts, chiefly the chromites, are usually reported to be relatively nontoxic; this is debatable, since exposures associated with toxic effects are usually mixed exposures involving several hexavalent chromium compounds. Ferrochrome alloys have been associated with pulmonary disease in humans. Four workers engaged in the production of ferrochrome alloys developed a nodular type of pulmonary disease with impairment of pulmonary function; air concentrations of chromium in this study averaged 0.26 mg/m^3, although other fumes and dusts were also present. This pulmonary problem may be one of hypersensitivity and thus reversible. Other reports state that chest roentgenograms have revealed only "exaggerated pulmonic markings" in workers exposed to chromite dust. The lungs of groups of workers exposed to chromite dust have been shown to be the seat of pneumoconiotic changes consisting of slight thickening of interstitial tissue and interalveolar septa, with histologic fibrosis and hyalinization. Chromite ore roast mixed with sheep fat implanted intrapleurally in rats produced squamous cell carcinomata coexisting with sarcomata of the lungs; the same material implanted in the thighs of rats produced fibrosarcomata. A refractory plant using chromite ore to make chromite brick had no excess of lung cancer deaths over a 14-year period, and it was concluded that chromite alone probably is not carcinogenic.

CHEMICAL AND PHYSICAL PROPERTIES

• **Physical data—Metallic chromium**

1. Molecular weight: 52
2. Boiling point (760 mm Hg): 2640 C (4784 F)
3. Specific gravity (water = 1): 7.2
4. Vapor density (air = 1 at boiling point of metallic chromium): Not applicable
5. Melting point: 1900 C (3452 F)
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble
8. Evaporation rate (butyl acetate = 1): Not applicable

• **Physical data—Copper chromite**

1. Molecular weight: 295.1
2. Boiling point (760 mm Hg): Data not available
3. Specific gravity (water = 1): 5.24
4. Vapor density (air = 1 at boiling point of copper chromite): Not applicable
5. Melting point: Data not available
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble
8. Evaporation rate (butyl acetate = 1): Not applicable

• **Physical data—Basic potassium zinc chromate**

1. Molecular weight: 873.8
2. Boiling point (760 mm Hg): Decomposes at red heat
3. Specific gravity (water = 1): 3.47
4. Vapor density (air = 1 at boiling point of basic potassium zinc chromate): Not applicable
5. Melting point: Loses water slowly above 100 C (212 F)
6. Vapor pressure at 20 C (68 F): Essentially zero
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble
8. Evaporation rate (butyl acetate = 1): Not applicable

• **Reactivity**

1. Conditions contributing to instability: None
2. Incompatibilities: Chromium metal in contact with strong oxidizers may cause fires and explosions.
3. Hazardous decomposition products: None listed.
4. Special precautions: None listed.

• **Flammability**

1. Flash point: Not applicable
2. Minimum ignition temperature (metal): 400 C (752 F) (layer); 580 C (1076 F) (cloud)
3. Minimum explosive dust concentration (metal): 230 $grams/m^3$
4. Extinguishant: Dry sand, dry dolomite, dry graphite

• **Warning properties**

Chromium metal and insoluble salts are not known to be eye irritants.

MONITORING AND MEASUREMENT PROCEDURES

• **Eight-Hour Exposure Evaluation**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• **Ceiling Evaluation**

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of chromium metal or insoluble chromium salts. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

• **Method**

Sampling and analyses may be performed by collection of chromium metal or insoluble chromium salts on a filter, followed by treatment with acid and atomic absorption spectrophotometric analysis. An analytical method for chromium metal and insoluble chromium salts is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 6, 1980, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00369-6).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with solids or liquids containing insoluble chromium salts.

• Clothing contaminated with insoluble chromium salts should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of insoluble chromium salts from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the insoluble chromium salts, the person performing the operation should be informed of insoluble chromium salts's hazardous properties.

• Non-impervious clothing which becomes contaminated with insoluble chromium salts should be removed promptly and not reworn until the insoluble chromium salts are removed from the clothing.

• Employees should be provided with and required to use dust- and splashproof safety goggles where solids or liquids containing insoluble chromium salts may contact the eyes.

SANITATION

• Skin that becomes contaminated with insoluble chromium salts should be promptly washed or showered with soap or mild detergent and water to remove any insoluble chromium salts.

• Eating and smoking should not be permitted in areas where solids or liquids containing insoluble chromium salts are handled, processed, or stored.

• Employees who handle solids or liquids containing insoluble chromium salts should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to chromium metal or insoluble chromium salts may occur and control methods which may be effective in each case:

Operation	Controls
Use in fabrication of alloys	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in preparation of alloy steels to enhance corrosion- and heat-resistance	Local exhaust ventilation; general dilution ventilation
Use in fabrication of plated products for decoration or increased wear-resistance	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in production of non-ferrous alloys to impart special qualities to the alloys	Local exhaust ventilation; general dilution ventilation
Use in production and processing of insoluble salts	Local exhaust ventilation; general dilution ventilation; personal protective equipment

Operation	Controls
Use as chemical intermediates; use in textile industry in dyeing, silk treating, printing, and moth-proofing wool	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use in leather industry in tanning; use in photograhic fixing baths	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Use as catalysts for halogenation, alkylation, and catalytic cracking of hydrocarbons	Local exhaust ventilation; general dilution ventilation
Use as fuel additives and propellant additives; in photogaphic fixing baths and in ceramics	Local exhaust ventilation; general dilution ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• **Eye Exposure**

If chromium metal or solids or liquids containing insoluble chromium salts get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. If irritation is present after washing, get medical attention. Contact lenses should not be worn when working with these chemicals.

• **Skin Exposure**

If solids or liquids containing insoluble chromium salts get on the skin, wash the contaminated skin using soap or mild detergent and water. If solids or liquids containing insoluble chromium salts penetrate through the clothing, remove the clothing and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

• **Breathing**

If a person breathes in large amounts of chromium metal or insoluble chromium salts, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• **Swallowing**

When solids or liquids containing insoluble chromium salts have been swallowed, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

• **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL, LEAK, AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of spills until cleanup has been completed.

• If chromium metal or insoluble chromium salts are spilled, the following steps should be taken:

1. Remove all ignition sources where metallic chromium has been spilled.
2. Ventilate area of spill.
3. Collect spilled material in the most convenient and safe manner and deposit in sealed containers for reclamation or for disposal in a secured sanitary landfill. Liquid containing chromium metal or insoluble chromium salts should be absorbed in vermiculite, dry sand, earth, or a similar material.

• Waste disposal method:

Chromium metal or insoluble chromium salts may be disposed of in sealed containers in a secured sanitary landfill.

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• SPECIAL NOTE

The International Agency for Research on Cancer (IARC) has evaluated the data on these chemicals and has concluded that they cause cancer. See *IARC Monographs on the Evaluation of Carcinogenic Risk of Chemicals to Man*, Volume 2, 1973, and Volume 23, 1980.

• **Method**

Sampling and analyses may be performed by collection of chromium metal or insoluble chromium salts on a filter, followed by treatment with acid and atomic

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RESPIRATORY PROTECTION FOR CHROMIUM METAL AND INSOLUBLE CHROMIUM SALTS (AS CHROMIUM)

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Condition	Minimum Respiratory Protection* Required Above 1 mg/m³
Particulate Concentration	
5 mg/m³ or less	Any dust and mist respirator.
10 mg/m³ or less	Any dust and mist respirator, except single-use or quarter-mask respirator. Any fume respirator or high efficiency particulate respirator. Any supplied-air respirator. Any self-contained breathing apparatus.
50 mg/m³ or less	A high efficiency particulate filter respirator with a full facepiece. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
500 mg/m³ or less	A powered air-purifying respirator with a high efficiency particulate filter. A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 500 mg/m³ or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.

*Only NIOSH-approved or MSHA-approved equipment should be used.

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LEAD

CAS: 7439-92-1

Pb

Inorganic Compounds, Dust and Fume

TLV-TWA, 0.15 mg/m³, as Pb*

Lead, atomic number 82, is metallic element in Group IVB of the periodic table. It is heavy, ductile, and bluish-white in color. Its physiochemical properties include:

Atomic weight: 207.2
Specific gravity: 11.35 at 20°C
Melting point: 327.5°C
Boiling point: 1740°C
Vapor pressure: significant above 500°C (1.77 torr at 1000°C)

Only a few lead compounds are appreciably soluble in water, but many are dissolved by acids and most are sufficiently soluble in body fluids to be toxic, especially when inhaled in finely divided form.

Metallic lead finds wide industrial use where its properties of high density, softness, low melting point, resistance to corrosion and/or opacity to gamma and X-rays are needed. It is a major component of many alloys such as solder, type metal, and many bronzes. Lead compounds have a wide variety of uses, especially as paint pigments, in storage batteries and ceramics.

Despite the tremendous importance of lead as an occupational hazard, only a handful of papers in the voluminous literature on lead poisoning present meaningful data relating to the threshold limit value. The chief reason for this situation is probably the fact that most authorities rely primarily, if not exclusively, on other tests for estimation of the degree of lead hazard. Urinary and blood leads, urinary coproporphyrin and delta aminolevulinic acid, as well as blood examination for stippled cells and other abnormalities, are among the preferred procedures.

A limit of 0.5 mg/m³ for lead in air was proposed by Legge in 1912, with the comment that, if adhered to, cases of encephalopathy and paralysis would never, and cases of colic would very rarely, occur.[1] The data of Duckering's experiments on the quantities of lead in the air from various industrial processes are given as evidence.[2] This value (0.5 mg/m³) was quoted by Alice Hamilton in 1925, with a similar comment.[3]

In 1933 Russell et al.[4] following a U.S. Public Health Service survey of a lead storage battery plant, proposed a limit of 0.15 mg/ for lead dust and fume in this industry. Eight years later Dreessen et al[5] published results of a follow-up study and considered that their findings confirmed this value. In 1943 Kehoe and other members of the Committee on Lead Poisoning of the American Public Health Association recommended 0.15 mg/m³, as a time-weighted average, limit.[6]

A number of investigators found the 0.15 mg/m³ value difficult to achieve in many industries, and observation of workers, combined with lead urinalysis and similar studies convinced them that this limit was unnecessarily stringent. Winn and Shroyer[7] concluded that maintenance of the average concentration of lead dust and fume at or below 0.5 mg/m³, combined with a medical program, would assure adequate control. Weber[8] considered the 0.15 mg/m³ too low, but stipulated that 0.3 mg/m³ should not be exceeded (as time-weighted average). He found that an atmospheric concentration of 0.43 mg/m³ corresponded to 0.20 mg/L of urine, a level considered by some investigators to represent the upper limit of safety. Elkins[9] assembled the data available on lead in air and lead in urine and concluded that a urinary lead concentration of 0.20 mg/L would, on the average, correspond to an air-lead value of 0.20 mg/m³.

On the basis of these reports and unpublished data from several sources, the TLV for lead was increased from 0.15 to 0.20 mg/m³ in 1957. Some authorities continued to use the previous limit, however.[10] Schrenk[11] implied that the 0.15 mg/m³ value was to be preferred. The preponderance of American opinion, however, seemed to be that the 0.2 mg/m³ limit was adequate to prevent episodes of lead intoxication. Thus Kehoe,[12] in a discussion of threshold limits for lead, stated that:

> *"Evidence of the validity of the standard (0.2 mg/m³) has been provided elsewhere and need not be enlarged upon here."*

He went on to warn that this value is adequate only if ingestion of lead is prevented. Johnstone and Miller[13] referred to the 0.2 mg/m³ limit as generally accepted.

More recent comparisons of atmospheric and urinary lead concentrations have indicated conflicting results. Berg and Zenz,[14] in a foundry study, found that air-lead concentrations between 0.14 and 0.18 mg/m³ resulted in urinary lead values below 0.15 mg/L; 0.28 mg/m³ was associated with 0.17 mg/L of urine.

Tsuchiya and Harashima[15] concluded that for a 48- to 60-hour work week, an average air-lead concentration of 0.10 mg/m³ would bring about an average urinary lead level of 0.15 mg/L; and 0.12 mg/m³ to 0.20 mg/L. Concentrations of 0.12 to 0.14 mg/m³ resulted in increased urinary coproporphyrin, some stippling of blood cells and anemia.

Most extensive lead exposure studies have involved lead oxide dust or the fume of metallic lead. Some reports have indicated that the dusts of certain insoluble lead compounds, such as the sulfide[16] and chromate, were less hazardous than more soluble forms of lead. Thus, Harrold and associates[17,18] studied a group of painters exposed to mists of lead chromate in concentrations averaging between 1.2 and 12 mg of lead per cubic meter of air, and found little evidence of lead absorption or intoxication. They also suggested that lead titanate would present relatively little hazard, due to its very low solubility.

On the other hand, Hartogenesis and Zielhuis[19] found blood changes in workers exposed to lead chromate dust at levels above 0.2 mg/m³ (as lead) and doubtful changes between 0.1 and 0.2 mg/m³. They consider that the TLV for lead chromate should be the same as that for other inorganic lead compounds.

Curiously, there is evidence that lead fume is less harmful than equal amounts of the dust of relatively soluble lead compounds.[20] This is presumed to be due to a lesser retention of the extremely fine particles present in the fume.

* In 1984 the STEL was placed on the Notice of Intended Changes as a deletion with the TWA value retained.

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The International Subcommittee for Occupational Health of the Permanent Commission and International Association of Occupational Health, at a meeting in Amsterdam in November 1966, recommended a limit of 0.15 mg/m³ for a 40-hour week. This conclusion represented the concensus of 20 experts from 12 nations.[11,12]

In an extremely thorough study of atmospheric lead exposures and biochemical criteria, Williams et al[13] found among 39 battery workers in England high correlation coefficients between air concentrations and blood lead ($r = 0.9$): urinary lead ($r = 0.82$): urinary coproporphyrins ($r = 0.82$) and urinary dALA ($r = 0.68$). Lower correlations were found for punctate (stippled) basophilic count ($r = 0.45$) and percent hemoglobin ($r = 0.09$). Furthermore, they observed that in every case the upper 95% confidence limit considerably exceeded the safe limits, when the air limit is 0.2 mg/m³, but approximates it when the air limit is 0.15 mg/m³.

In view of these data using improved biochemical indicators of lead exposure, clearly showing that the TLV of 0.2 mg/m³ had little or no margin of safety for some workers, the limit was reduced back to 0.15 mg/m³ in 1971.

In its first criteria document on inorganic lead, published in 1972, NIOSH recommended the 0.15 mg/m³ TLV as a workplace standard,[14] but emphasized that reliance should be placed primarily on biological measurements, especially blood lead, for which the limit of 0.08 mg/100 grams was endorsed. A revised document appeared in 1978, however, in which a lower limit, 0.1 mg/m³, was proposed.[15] The maximum permissible blood lead level was also reduced, to 0.06 from 0.08 mg/100 grams.

Emphasis in the document is placed on findings of adverse effects among workers with blood leads below 0.08 mg/100 grams, but generally above 0.06 mg.

Although the updated document contains 185 additional references (most published since 1971), only five relate directly to atmospheric lead concentrations, and these are all given as support for the amazing statement that "it has been shown that 1 μg lead/m³ in air contributes about 1-2 μg lead/100 grams of blood." Amazing, that is, until examination of the references indicates that four of them deal with continuous exposures of the public, or volunteers, to lead in air levels of the order of 0.01 mg/m³ or less. Only one[16] relates to occupational exposure; a mean lead in air concentration in one department of a rubber hose and tire company in Japan of 0.0579 mg/m³ (based on 34 tests) was associated with a mean blood lead level, in 20 workers, of 51.8 μg/100 grams.

In addition, testimony of the Deputy Director of NIOSH at an OSHA hearing refers to an unpublished battery plant study in which average exposures of workers, using personal monitors, were below 0.1 mg/m³ in all departments except pasting and grid casting, where exposures were generally below 0.15 mg/m³.[17] Blood levels in over 90% of the workers were 60 μg/100 grams or less.

The findings of these two reports are hardly adequate to justify the proposed reduction in the limit for lead in workroom air.

The papers on effects associated with blood lead levels below 80 μg/100 grams are also few in number. Findings of changes in urinary ALA and coproporphyrin, erythrocyte protoporphyrin and zinc protoporphyrin in blood, hemoglobin decreases, and altered spermatogenesis are reported in conjunction with likely "excessive absorption," as evidenced by blood leads between 40 and 60 μg/100 grams. The proposed standard apparently would not recognize these effects as inconsistent with a satisfactory state of health. Unacceptable lead absorption, with blood leads in excess of 60 μg/100 grams (mostly, but not entirely, below 80 μg) are associated with CNS effects, peripheral neuropathy, gastrointestinal disturbances and anemia, according to one reference.[18] Another paper[19] cited reported evidence of renal damage in six of thirteen workers, one with a blood lead of 98 μg/100 grams, one with 66 μg, and the remainder below 60 μg/100 grams of blood. An unpublished NIOSH report[20] found renal damage and anemia in similarly exposed (blood leads above 60 μg/100 grams, but presumably not over 80 μg) workers, but no details are given.

Perhaps the strongest case for the reduced limit is presented in a paper on nerve conduction velocities,[21] in which decreases (mostly minimal, but in one system significant) were found in workers with maximal blood leads between 50 and 70 μg/100 grams. The authors felt that these findings were more serious than the alterations in heme synthesis, demonstrated by biochemical measurements, since the regenerative capacity of the nervous system is relatively slow.

The Committee is not convinced that the biochemical changes found due to low level lead absorption are incompatible with good health. It has not adopted, or proposed, a biologic TLV for lead, nor has it accepted the NIOSH hypothesis that an air TLV must be set at a level at which most workers (i.e., 90-95%) do not exceed a specified *biologic* TLV.

In view of the notation in the title of the consultant's review of the recent literature in the revised NIOSH document[15] that it is to "support the update" of the criteria document, one wonders if the citations are chosen and their contents summarized without bias.

For the present, the time-weighted average TLV of 0.15 mg lead/m³ in air is retained. However, the Committee recommends, at this time, the elimination of the STEL until additional toxicological data and industrial hygiene experience become available to provide a better base for quantifying on a toxicological basis what the STEL should be. The reader is encouraged to review the section on *Excursion Limits* in the Introduction to the Chemical Substances of the current TLV booklet for guidance and control of excursions above the TLV-TWA, even when the 8-hour TWA is within the recommended limits.

Other recommendations: The American National Standard Institute's Z-37 Committee established 0.2 mg/m³ as its acceptable concentration for lead in 1969. Smyth (1956) suggested that even the 0.15 mg/m³ value was not low enough to prevent mild intoxication. More recent values are: USSR (1977) 0.01 mg/m³; Hungary (1974) 0.02 mg/m³; Czechoslovakia (1976), Poland (1976) and OSHA (1978) 0.05 mg/m³; Romania (1975), Sweden (1975) and West Germany (1978) 0.1 mg/m³; East Germany (1973), Finland (1975) and Yugoslavia (1971) 0.15 mg/m³.

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Occupational Health Guideline for Copper Dusts and Mists

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formulas of example compounds: $CuSO_4 \cdot 5H_2O$; CuCl
- Example compounds: Copper sulfate dust or mist; cuprous chloride dust
- Appearance and odor: Odorless solids

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for copper dusts or mists is 1 milligram of copper dusts or mists per cubic meter of air (mg/m^3) averaged over an eight-hour work shift.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Copper dusts or mists can affect the body if they are inhaled or if they come in contact with the eyes or skin. They can also affect the body if they are swallowed.

- **Effects of overexposure**

1. Short-term Exposure: Powdered copper or dusts or mists of copper salts may cause a feeling of illness similar to the common cold with sensations of chills and stuffiness of the head. Small copper particles may enter the eye and cause irritation, discoloration, and damage.

2. Long-term Exposure: Repeated or prolonged exposure to copper dusts or mists may cause skin irritation or discoloration of the skin or hair.

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to copper dusts or mists.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to copper dusts and mists at potentially hazardous levels:

1. Initial Medical Screening: Employees should be screened for history of certain medical conditions (listed below) which might place the employee at increased risk from copper dusts and mists exposure.

—Chronic respiratory disease: Copper dusts or mists cause respiratory irritation in animals. In persons with impaired pulmonary function, especially those with obstructive airway diseases, the breathing of copper dusts or mists might cause exacerbation of symptoms due to their irritant properties.

—Liver disease: Copper dusts or mists cause liver damage in animals. Persons with pre-existing liver disease may be more susceptible to the effects of these agents.

—Kidney disease: Copper dusts or mists cause kidney damage in animals. The importance of this organ in the elimination of toxic substances justifies special consideration in those with impaired renal function.

—Skin disease: Skin sensitization in human subjects has occurred. Persons with pre-existing skin disorders may be more susceptible to the effects of these agents.

—Hematopoietic disorders: Anemia has occurred in animals given copper salts orally. Persons with pre-existing blood disorders may be more susceptible to the effects of these agents.

—Wilson's disease: Persons with pre-existing Wilson's disease may be more susceptible to the effects of these agents.

2. Periodic Medical Examination: Any employee developing the above-listed conditions should be referred for further medical examination.

- **Summary of toxicology**

Inhalation of dusts and mists of copper and copper salts results in irritation of the upper respiratory tract, with occasional ulceration and perforation of the nasal septum. Inhalation of copper and its compounds by animals caused injury to the lungs and liver with

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These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service Centers for Disease Control
National Institute for Occupational Safety and Health

U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

September 1978

hemochromatosis. Access of sheep to salt licks containing 5 to 9% copper sulfate caused the sudden onset of hemolytic anemia, icterus, and hemoglobinuria followed by death in a day or two; at necropsy, the liver, kidneys, and spleen showed severe degenerative changes. Workers exposed to copper dust in concentrations of 0.075 to 0.120 mg/m^3 complained of mild nasal discomfort. Exposure to the dust of copper acetate produced sneezing, coughing, digestive disorders, and fever. Metal workers exposed to complex copper salts in dust form complained of metallic taste with irritation of nasal and oral mucosa; atrophic changes in the mucous membranes were noted in subjects exposed for long periods of time. On ingestion, copper salts act as irritants and cause nausea, vomiting, abdominal pain, hemorrhagic gastritis, and diarrhea. Copper salts splashed in the eye cause conjunctivitis, corneal ulceration, and turbidity, and may produce palpebral edema. Copper particles embedded in the eye result in pronounced foreign-body reaction with characteristic discoloration of ocular tissue. Allergic contact dermatitis due to copper exposure, although rare, has been reported. Greenish discoloration of the skin and hair of some copper workers has been observed. Although copper is an essential element for health, excessive amounts can produce harmful effects.

CHEMICAL AND PHYSICAL PROPERTIES

• **Physical data**

1. Molecular weight: $CuSO_4$: 249.7; $CuCl_2$: 99
2. Boiling point (760 mm Hg): Not applicable
3. Specific gravity (water = 1): Greater than 1
4. Vapor density (air = 1 at boiling point of copper dusts or mists): Not applicable
5. Melting point: Higher than 100 C (212 F). For example, copper sulfate = 150 C (302 F); cuprous chloride = 430 C (806 F)
6. Vapor pressure at 20 C (68 F): Not applicable
7. Solubility in water, g/100 g water at 20 C (68 F): Ranges from very low (e.g. cuprous chloride = 0.006) to high (e.g. copper sulfate = 35)
8. Evaporation rate (butyl acetate = 1): Not applicable

• **Reactivity**

1. Conditions contributing to instability: Extreme heat
2. Incompatibilities: Copper dusts or mists may react with acetylene gas to form copper acetylides, which are solids that are sensitive to shock. Some copper mists may react with magnesium metal to form flammable hydrogen gas.
3. Hazardous decomposition products: None
4. Special precautions: None

• **Flammability**

1. Ignition temperature: Copper dusts = 700 C (1292 F)

• **Warning properties**

According to Grant, copper acetoarsenite, copper chloride, copper sulfate, copper carbonate and oxide, and copper metal all produce local irritant effects when in contact with the eye. The *Documentation of TLV's* also notes that copper salts on the eye may cause "conjunctivitis or even ulceration and turbidity of the cornea." Concentrations producing these effects are not given.

MONITORING AND MEASUREMENT PROCEDURES

• **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• **Method**

Sampling and analyses may be performed by collection of copper dusts or mists on a cellulose ester membrane filter, followed by treatment with nitric acid, solution in hydrochloric acid, and atomic absorption spectrophotometric analysis. An analytical method for copper dusts or mists is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 2, 1977, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00260-6).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

PERSONAL PROTECTIVE EQUIPMENT

• Employees should be provided with and required to use impervious clothing, gloves, face shields (eight-inch minimum), and other appropriate protective clothing necessary to prevent repeated or prolonged skin contact with copper salts or liquids containing copper salts.

• If employees' clothing may have become contaminated with powdered copper, copper salts, or liquids containing copper salts, employees should change into uncontaminated clothing before leaving the work premises.

• Clothing contaminated with copper salts should be placed in closed containers for storage until it can be discarded or until provision is made for the removal of copper salts from the clothing. If the clothing is to be laundered or otherwise cleaned to remove the copper salts, the person performing the operation should be informed of copper salts's hazardous properties.

• Non-impervious clothing which becomes contaminated with copper salts should be removed promptly and not reworn until the copper salts are removed from the clothing.

• Employees should be provided with and required to use dust- and splash-proof safety goggles where powdered copper or dusts, mists, or liquids containing copper salts may contact the eyes.

SANITATION

• Skin that becomes contaminated with copper salts should be promptly washed or showered with soap or mild detergent and water to remove any copper salts.

• Eating and smoking should not be permitted in areas where powdered copper, copper salts, or liquids containing copper salts are handled, processed, or stored.

• Employees who handle powdered copper, copper salts, or liquids containing copper salts should wash their hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to copper dusts or mists may occur and control methods which may be effective in each case:

Operation	Controls
Liberation during mining, extracting, and refining copper ore; during fabrication and manufacture of copper rod, wire, piping, and tubing for use in electrical, plumbing, and building industries; during manufacture of domestic utensils; during manufacture of alloys	Local exhaust ventilation; general dilution ventilation; personal protective equipment
Liberation from production and application of fungicides, insecticides, and germicides for soil, feed, grain, textile, water and sewage treatments; during use of copper salts for paint pigments and coloring agents, electroplating baths, wood preservation, automotive emission controls, textile treatment, and organic synthesis	Local exhaust ventilation; general dilution ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• **Eye Exposure**

If copper dusts or mists get into the eyes, wash eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with these chemicals.

• **Skin Exposure**

If copper salts or liquids containing copper salts get on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If copper salts or liquids containing copper salts penetrate through the clothing, remove the clothing promptly and wash the skin using soap or mild detergent and water. If irritation persists after washing, get medical attention.

• **Breathing**

If a person breathes in large amounts of copper dusts or mists, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• **Swallowing**

When powdered copper, copper salts, or liquids containing copper salts have been swallowed and the person is conscious, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.

• **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILL AND DISPOSAL PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of release until cleanup has been completed.

• If copper dusts or mists are spilled or released, the following steps should be taken:

1. Ventilate area of release.
2. Collect spilled material in the most convenient and safe manner for reclamation, or for disposal in a secured sanitary landfill. Liquid containing copper should be absorbed in vermiculite, dry sand, earth, or a similar material.

• Waste disposal method:

Copper dusts or mists and copper compounds may be disposed of in sealed containers in a secured sanitary landfill.

REFERENCES

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RESPIRATORY PROTECTION FOR COPPER DUSTS AND MISTS

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Condition	Minimum Respiratory Protection* Required Above 1 mg/m³
Particulate Concentration	
50 mg/m³ or less	A high efficiency particulate filter respirator with a full facepiece.
	Any supplied-air respirator with a full facepiece, helmet, or hood.
	Any self-contained breathing apparatus with a full facepiece.
2000 mg/m³ or less	A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode.
Greater than 2000 mg/m³ or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
	A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.

*Only NIOSH-approved or MSHA-approved equipment should be used.

Occupational Health Guideline for Zinc Oxide Fume

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: ZnO
- Synonyms: None
- Appearance: White fume.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for zinc oxide fume is 5 milligrams of zinc oxide fume per cubic meter of air (mg/m^3) averaged over an eight-hour work shift. NIOSH has recommended that the permissible exposure limit be changed to 5 mg/m^3 averaged over a work shift of up to 10 hours per day, 40 hours per week, with a ceiling level of 15 mg/m^3 averaged over a 15-minute period. The NIOSH Criteria Document for Zinc Oxide should be consulted for more detailed information.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Zinc oxide fume can affect the body if it is inhaled.

- **Effects of overexposure**

1. Short-term Exposure: Zinc oxide fume causes a flu-like illness called metal fume fever. Symptoms of metal fume fever include headache, fever, chills, muscle aches, nausea, vomiting, weakness, and tiredness. The symptoms usually start several hours after exposure. The attack may last 6 to 24 hours. Metal fume fever is more likely to occur after a period away from the job (after weekends or vacations). High levels of exposure to zinc oxide fume may cause a metallic or sweet taste in the mouth, dryness and irritation of the throat, and coughing at the time of exposure.

2. Long-term Exposure: None known.

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to zinc oxide fume.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to zinc oxide fume at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the respiratory system should be stressed.

—14" x 17" chest roentgenogram: Zinc oxide fume may cause respiratory impairment. Persons with pulmonary disease may be more susceptible to the effect os zinc oxide fume. Surveillance of the lungs is indicated.

—FVC and FEV (1 sec): Persons with pre-existing pulmonary disease may be more susceptible to the effects of zinc oxide fume. Periodic surveillance is indicated.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis, except that an x-ray is considered necessary only when indicated by the results of pulmonary function testing. Determination of zinc in the urine may be helpful in evaluating the extent of absorption.

- **Summary of toxicology**

Inhalation of zinc oxide fume causes an influenza-like illness termed metal fume fever. Heavy human exposure to zinc oxide fume may cause an immediate dryness and irritation of the throat, a sweet or metallic taste followed by substernal tightness and constriction in the chest, and a dry cough. Several hours following exposure the subject develops fever, lassitude, malaise, fatigue, frontal headache, low back pain, muscle cramps, and occasionally blurred vision, nausea, and vomiting.

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

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Physical examination reveals fever, eventually followed by perspiration and chills, dyspnea, rales throughout the chest, and tachycardia; in some instances there has been a reversible reduction in pulmonary vital capacity; there is usually leukocytosis, which may amount to 12,000 to 16,000/MM3. An attack usually subsides after 6 to 12 hours but may last for up to 24 hours; recovery is usually complete. Most workers rapidly develop an immunity to these attacks, but it is as quickly lost; attacks tend to be more severe on the first day of the work-week. Only freshly formed fume causes the illness, presumably because flocculation occurs in the air; the larger particles that form are deposited in the upper respiratory tract and do not penetrate deeply into the lungs. Chills have been reported in workers from exposure to concentrations of zinc oxide fume below 5 mg/m^3.

CHEMICAL AND PHYSICAL PROPERTIES

• **Physical data**

1. Molecular weight: 81.37
2. Boiling point (760 mm Hg): Solid sublimes
3. Specific gravity (water = 1): 5.6 (solid)
4. Vapor density (air = 1 at boiling point of zinc oxide fume): Not applicable
5. Melting point: Greater than 1800 C (greater than 3272 F)
6. Vapor pressure at 20 C (68 F): Not applicable
7. Solubility in water, g/100 g water at 20 C (68 F): Insoluble (solid)
8. Evaporation rate (butyl acetate = 1): Not applicable

• **Reactivity**

1. Conditions contributing to instability: None
2. Incompatibilities: Zinc oxide fume may react violently with chlorinated rubber.
3. Hazardous decomposiiton products: None
4. Special precautions: None

• **Flammability**

1. Not combustible

• **Warning properties**

Zinc oxide fume is not known to be an eye irritant.

MONITORING AND MEASUREMENT PROCEDURES

• **Eight-Hour Exposure Evaluation**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

• **Ceiling Evaluation**

Measurements to determine employee ceiling exposure are best taken during periods of maximum expected airborne concentrations of zinc oxide fume. Each measurement should consist of a fifteen (15) minute sample or series of consecutive samples totalling fifteen (15) minutes in the employee's breathing zone (air that would most nearly represent that inhaled by the employee). A minimum of three (3) measurements should be taken on one work shift and the highest of all measurements taken is an estimate of the employee's exposure.

• **Method**

Sampling and analyses may be performed by collection of zinc oxide on a cellulose membrane filter, followed by solublizing the zinc with nitric acid and analyzing by atomic absorption spectrophotometry. An analytical method for zinc oxide fume is in the *NIOSH Manual of Analytical Methods*, 2nd Ed., Vol. 4, 1978, available from the Government Printing Office, Washington, D.C. 20402 (GPO No. 017-033-00317-3).

RESPIRATORS

• Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.

• In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to zinc oxide fume may occur and control methods which may be effective in each case:

Operation	Controls
Liberation during brazing, welding, burning, and cutting of zinc and galvanized metals	General dilution ventilation; process enclosure; local exhaust ventilation; personal protective equipment
Liberation from founding of brass, copper, and zinc, and galvanizing of iron and steel	General dilution ventilation; process enclosure; local exhaust ventilation; personal protective equipment
Liberation from abrasive cleaning of galvanized metal surface	General dilution ventilation; process enclosure; local exhaust ventilation; personal protective equipment
Liberating during use as a ceramic flux	General dilution ventilation; process enclosure; local exhaust ventilation; personal protective equipment
Liberation during recovery of impure lead blast furnace slag; from manufacture of glass to increase brilliance and luster of glass	General dilution ventilation; process enclosure; local exhaust ventilation; personal protective equipment
Liberation from use as an intermediate in manufacture of other zinc compounds; in manufacture of electronic devices	General dilution ventilation; process enclosure; local exhaust ventilation; personal protective equipment
Liberation from use as a filler material in crushed stone industry	General dilution ventilation; personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• **Breathing**

If a person breathes in large amounts of zinc oxide fume, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

LEAK PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of releases until cleanup has been completed.

• If potentially hazardous amounts of zinc oxide fume are inadvertently released, ventilate the area of the release to disperse the fume.

REFERENCES

• American Conference of Governmental Industrial Hygienists: "Zinc Oxide Fume," *Documentation of the Threshold Limit Values for Substances in Workroom Air* (3rd ed., 2nd printing), Cincinnati, 1974.

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RESPIRATORY PROTECTION FOR ZINC OXIDE FUME

Condition	Minimum Respiratory Protection* Required Above 5 mg/m³
Particulate Concentration	
50 mg/m³ or less	Any fume respirator or high efficiency particulate filter respirator. Any supplied-air respirator. Any self-contained breathing apparatus.
250 mg/m³ or less	A high efficiency particulate filter respirator with a full facepiece. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
2,500 mg/m³ or less	A powered air-purifying respirator with a high efficiency particulate filter. A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous-flow mode.
Greater than 2,500 mg/m³ or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.

*Only NIOSH-approved or MSHA-approved equipment should be used.

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Occupational Health Guideline for Zinc Chloride Fume

INTRODUCTION

This guideline is intended as a source of information for employees, employers, physicians, industrial hygienists, and other occupational health professionals who may have a need for such information. It does not attempt to present all data; rather, it presents pertinent information and data in summary form.

SUBSTANCE IDENTIFICATION

- Formula: $ZnCl_2$
- Synonyms: None
- Appearance and odor: White fume with an acrid odor.

PERMISSIBLE EXPOSURE LIMIT (PEL)

The current OSHA standard for zinc chloride fume is 1 milligram of zinc chloride fume per cubic meter of air (mg/m^3) averaged over an eight-hour work shift.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Zinc chloride fume can affect the body if it is inhaled or if it comes in contact with the eyes.

- **Effects of overexposure**

1. Short-term Exposure: Exposure to zinc chloride fume may cause shortness of breath, a feeling of constriction in the chest, abdominal pain, watering of the eyes, burning of the eyes and throat, and coughing with phlegm and bloody sputum. It may also cause a blue color of the skin and lips. In addition, it may cause pneumonia. Breathing difficulties may not appear for several hours after exposure has ceased. Fatal exposures have occurred.

2. Long-term Exposure: None known.

3. Reporting Signs and Symptoms: A physician should be contacted if anyone develops any signs or symptoms and suspects that they are caused by exposure to zinc chloride fume.

- **Recommended medical surveillance**

The following medical procedures should be made available to each employee who is exposed to zinc chloride fume at potentially hazardous levels:

1. Initial Medical Examination:

—A complete history and physical examination: The purpose is to detect pre-existing conditions that might place the exposed employee at increased risk, and to establish a baseline for future health monitoring. Examination of the respiratory system should be stressed. The skin should be examined for evidence of chronic disorders.

—14" x 17" chest roentgenogram: Zinc chloride fume causes human lung damage. Surveillance of the lungs is indicated.

—FVC and FEV (1 sec): Zinc chloride fume is reported to cause decreased pulmonary function. Periodic surveillance is indicated.

2. Periodic Medical Examination: The aforementioned medical examinations should be repeated on an annual basis, except that an x-ray is considered necessary only when indicated by the results of pulmonary function testing. Determination of zinc in the urine may be helpful in evaluating the extent of absorption.

- **Summary of toxicology**

Zinc chloride fume irritates the eyes, mucous membranes, and skin, and causes delayed pulmonary edema. Ten deaths and 25 cases of non-fatal injury occurred among 70 persons exposed to a high concentration of zinc chloride released from smoke generators; presenting symptoms were conjunctivitis (two with burns of the corneas), irritation of nose and throat, cough with copious sputum, dyspnea, constrictive sensation in the chest, stridor, retrosternal pain, nausea, epigastric pain, and pale gray cyanosis. Of the 10 fatalities, a few died immediately or in a few hours from pulmonary edema, while those who survived longer developed bronchopneumonia. Between the second and fourth days after exposure, almost all cases developed moist, adventitious sounds in the lungs, and the majority continued to

These recommendations reflect good industrial hygiene and medical surveillance practices and their implementation will assist in achieving an effective occupational health program. However, they may not be sufficient to achieve compliance with all requirements of OSHA regulations.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
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Occupational Safety and Health Administration

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present a pale cyanotic color; a prominent feature was the disparity between the severe symptoms and the paucity of physical signs in the lungs; recovery occurred within 1 to 6 weeks after the incident. A firefighter was fatally exposed to a high but undetermined concentration of zinc chloride fume from a smoke generator; on admission to the hospital, the patient complained of nausea, sore throat, and chest tightness aggravated by deep inspiration. He initially improved but then developed tachypnea, substernal soreness, fever, cyanosis, and coma; the lung fields were clear on auscultation despite diffuse pulmonary infiltrations seen on the chest roentgenogram; death occurred 18 days after exposure, and autopsy revealed active fibroblastic proliferation and cor pulmonale. Injection of zinc chloride solution into the testes of 49 Syrian hamsters resulted in areas of necrosis occupying about 25% of each testis; two embryonal carcinomata of the testis were found 10 weeks later at necropsy.

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**
  1. Molecular weight: 136.3
  2. Boiling point (760 mm Hg): 732 C (1350 F) (for solid)
  3. Specific gravity (water = 1): 2.91 (solid)
  4. Vapor density (air = 1 at boiling point of zinc chloride fume): Not applicable
  5. Melting point: 283 C (541 F) (for solid)
  6. Vapor pressure at 20 C (68 F): Not applicable
  7. Solubility in water, g/100 g water at 25 C (77 F): 81
  8. Evaporation rate (butyl acetate = 1): Not applicable
- **Reactivity**
  1. Conditions contributing to instability: None
  2. Incompatibilities: None
  3. Hazardous decomposition products: None
  4. Special precautions: None
- **Flammability**
  1. Not combustible
- **Warning properties**

Grant states that "dilute solutions (0.2% to 1%) have long been used as astringent eye drops without difficulty, but concentrated solutions and pastes such as encountered industrially have caused very severe injuries of the cornea in numerous cases of accidental splash in the eye. . . . Guillery found that applying 10% zinc chloride solution for 4 to 5 minutes to a rabbit's eye caused loss of corneal endothelium and extensive infiltration." No information is available concerning the effects on the eye specifically of the fume of zinc chloride.

The *Documentation of TLVs* reports, "Elkins stated that zinc chloride is an irritant . . . . Ferry, in investigating a borderline condition, found that levels between 0.07 and 0.4 mg/m³ for 30 minutes did not result in sensory effects. The fume is corrosive to metals at these levels, however."

MONITORING AND MEASUREMENT PROCEDURES

- **General**

Measurements to determine employee exposure are best taken so that the average eight-hour exposure is based on a single eight-hour sample or on two four-hour samples. Several short-time interval samples (up to 30 minutes) may also be used to determine the average exposure level. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).

- **Method**

At the time of publication of this guideline, no measurement method for zinc chloride fume had been published by NIOSH.

RESPIRATORS

- Good industrial hygiene practices recommend that engineering controls be used to reduce environmental concentrations to the permissible exposure level. However, there are some exceptions where respirators may be used to control exposure. Respirators may be used when engineering and work practice controls are not technically feasible, when such controls are in the process of being installed, or when they fail and need to be supplemented. Respirators may also be used for operations which require entry into tanks or closed vessels, and in emergency situations. If the use of respirators is necessary, the only respirators permitted are those that have been approved by the Mine Safety and Health Administration (formerly Mining Enforcement and Safety Administration) or by the National Institute for Occupational Safety and Health.
- In addition to respirator selection, a complete respiratory protection program should be instituted which includes regular training, maintenance, inspection, cleaning, and evaluation.

COMMON OPERATIONS AND CONTROLS

The following list includes some common operations in which exposure to zinc chloride fume may occur and control methods which may be effective in each case:

Operation	Controls
Liberation from fluxing iron/steel prior to galvanizing	Process enclosure; general dilution ventilation; local exhaust ventilation; personal protective equipment
Liberation from arc welding of galvanized iron and steel pipes	Process enclosure; general dilution ventilation; local exhaust ventilation; personal protective equipment
Liberation from fluxing agent in some solder composition	Process enclosure; general dilution ventilation; local exhaust ventilation; personal protective equipment
Liberation from vulcanizing and reclaiming processes for rubber	Process enclosure; general dilution ventilation; local exhaust ventilation; personal protective equipment
Liberation from solutions in glass and metal etching	Process enclosure; general dilution ventilation; local exhaust ventilation; personal protective equipment
Liberation from manufacture of dry cell batteries	Process enclosure; general dilution ventilation; local exhaust ventilation; personal protective equipment
Liberation from petroleum refining operations	Process enclosure; general dilution ventilation; local exhaust ventilation

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, institute first aid procedures and send for first aid or medical assistance.

• **Breathing**

If a person breathes in large amounts of zinc chloride fume, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.

• **Rescue**

Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

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LEAK PROCEDURES

• Persons not wearing protective equipment and clothing should be restricted from areas of releases until cleanup has been completed.

• If potentially hazardous amounts of zinc chloride fume are inadvertently released, ventilate the area of the release to disperse the fume.

REFERENCES

• American Conference of Governmental Industrial Hygienists: "Zinc Chloride Fume," *Documentation of the Threshold Limit Values for Substances in Workroom Air* (3rd ed., 2nd printing), Cincinnati, 1974.

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RESPIRATORY PROTECTION FOR ZINC CHLORIDE FUME

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Condition	Minimum Respiratory Protection* Required Above 1 mg/m³
Particulate Concentration	
10 mg/m³ or less	Any fume respirator or high efficiency particulate filter respirator. Any supplied-air respirator. Any self-contained breathing apparatus.
50 mg/m³ or less	A high efficiency particulate filter respirator with a full facepiece. Any supplied-air respirator with a full facepiece, helmet, or hood. Any self-contained breathing apparatus with a full facepiece.
1000 mg/m³ or less	A powered air-purifying respirator with a full facepiece and a high efficiency particulate filter.
2000 mg/m³ or less	A Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure mode or with a full facepiece, helmet, or hood operated in continuous-flow mode.
Greater than 2000 mg/m³ or entry and escape from unknown concentrations	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode. A combination respirator which includes a Type C supplied-air respirator with a full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.
Fire Fighting	Self-contained breathing apparatus with a full facepiece operated in pressure-demand or other positive pressure mode.
Escape	A high efficiency particulate filter respirator. Any escape self-contained breathing apparatus.

*Only NIOSH-approved or MSHA-approved equipment should be used.

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APPENDIX C

EMERGENCY ASSISTANCE AGENCIES AND CONTACTS

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EMERGENCY ASSISTANCE AGENCIES AND CONTRACTS

Emergency Telephone Numbers

Police	911 or
Northeast Substation	(713) 699-3460
5703 Eastex Freeway	
Main Number	(713) 247-5420
Hospital	
Lyndon B. Johnson General Hospital	911 or
5656 Kelley Street	(713) 636-5000
Houston, TX 77026	
Fire Department/Ambulance	911 or
333 Preston	(713) 247-5000
Houston, TX 77002	
Texas State Troopers	(713) 681-1761
City Switchboard	(713) 247-1000
Harris County Sheriff	911 or
(713) 221-6044	
To Report Toxic Chemical and Oil Spills	1-800-424-8802

Health Information Services

Poison Control Center	(713) 654-1701
Tox Line	(301) 496-1131
CHEMTREC (24 hour)	(800) 434-9300

Project Office Personnel (Contacts)

Project Manager	(TBD)

Beazer East, Inc.

Shannon K. Craig, Program Manager	(412) 227-2684 (work) (412) 367-4069 (home)

Beazer Environmental Services, Inc.

Michael P. Helbling, Project Manager	(412) 227-2690 (work) (412) 733-4627 (home)

Environmental Protection Agency

Mark Fite, Remediation Project Manager	(214) 655-6715

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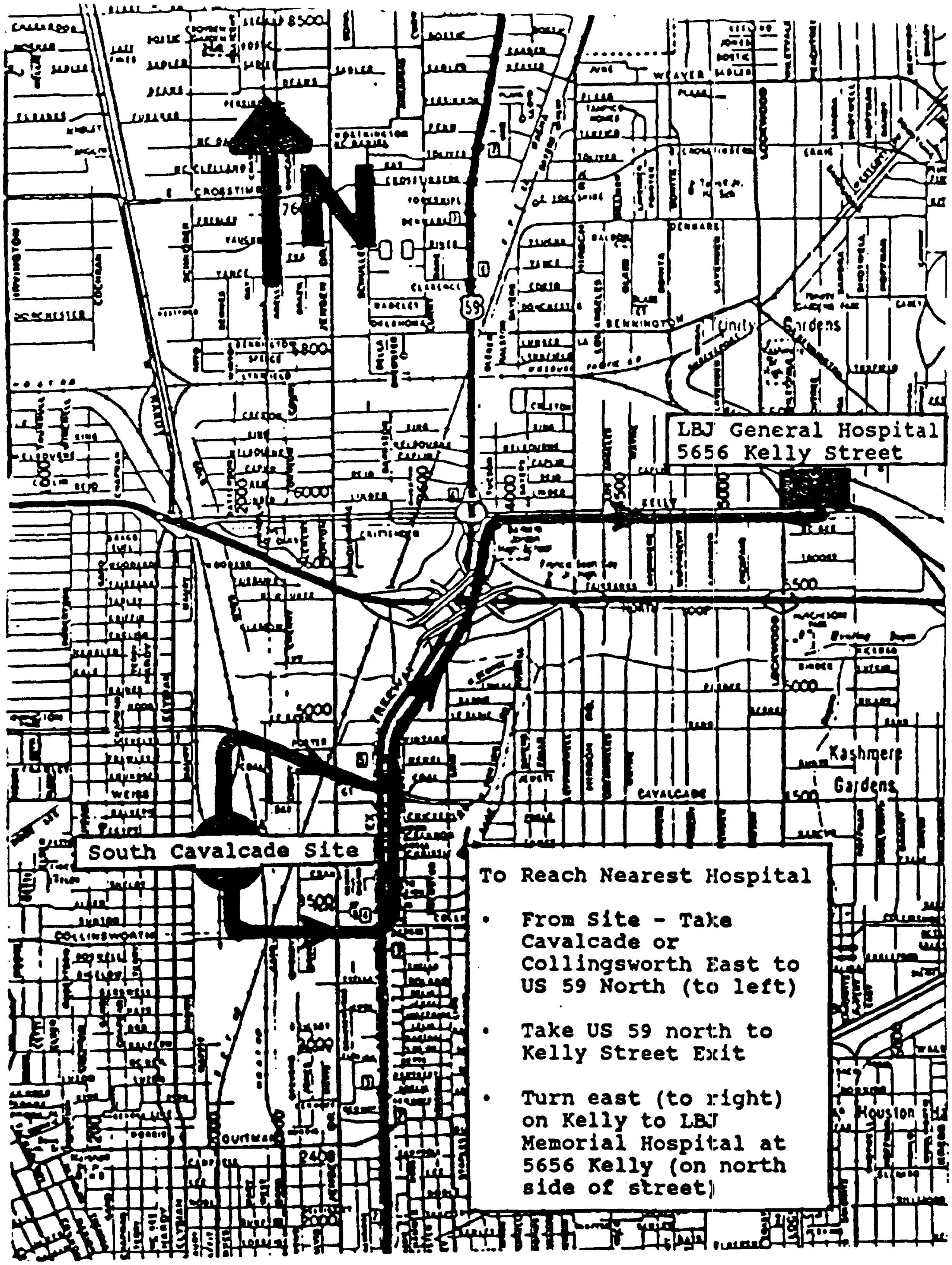
APPENDIX D

EMERGENCY ROUTE TO LBJ GENERAL HOSPITAL


LBJ General Hospital
5656 Kelly Street
South Cavalcade Site
To Reach Nearest Hospital
• From Site - Take Cavalcade or Collingsworth East to US 59 North (to left)
• Take US 59 north to Kelly Street Exit
• Turn east (to right) on Kelly to LBJ Memorial Hospital at 5656 Kelly (on north side of street)
N
Trinity Gardens
Kashmere Gardens
Houston
CAVALCADE
COLLINSWORTH
KELLY
59

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APPENDIX E

TYPES AND USES OF FIRE EXTINGUISHERS

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TYPES AND USES OF FIRE EXTINGUISHERS

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DRY CHEMICAL

Dry chemical extinguishers will be used to extinguish most small fires. The extinguishers shall be placed for easy access during site work activities that include:

- use of solvents (e.g., washing split spoons)
- storage of flammable liquids
- sampling or removing flammable soils

Dry chemical extinguishers will be available in the following capacity:

10 lb ABC dry chemical
20 lb ABC dry chemical

NOTES: Nonexplosion-proof or sparkling equipment is prohibited from areas where flammable solvents or flammable gases are present.

APPENDIX F

AIR MONITORING ACTION LEVELS

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ACTION LEVELS OBTAINED FROM DIRECT READING MEASUREMENTS

A. Gases and Vapors

1. Organic Survey Mode

Measurement (PPM Above Background)	Action and Level of Protection
Background to ≤10 ppm above background	Monitor site constituent level in or near breathing zone of worker. No respiratory protection required.
>10 ppm < 100 ppm	Monitor contaminant level in or near breathing zone of workers Level C protection.
>100 ppm	Stop work activities.

2. Combustible Gas

Measurement (% LEL)	Action
>10 to 25	Limit activities in area to those that do not generate sparks, non-sparking tools and gear, investigate source of combustible gas.
>25	Limit all activities in area, stop work activities.

3. Oxygen Level

Measurement (in percent)	Action and Protective Equipment
<19.5	Monitor while wearing SCBA.
19.5 - 25	Continue measurements with respiratory protection equipment based on other factors such as the presence of toxic air contaminants.
>25	Fire hazard potential exists, stop work activities.

B. Particulate Level (Respirable Dust Monitor)

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Measurement mg/m^3	Action and Protective Equipment
≤ 1	No respiratory protection required.
1 to ≤5	Level C protection. Air purifying respirator should be equipped with high efficiency/organic vapor/acid gas combination cartridges. Basic dust control techniques shall be used for all intrusive activities.
>5 to ≤10	Upgrade to B-level protection. Collect air sample information.
>10	Stop work activities.

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APPENDIX G

SPILL/VOLATILE EMISSIONS RELEASE

CONTINGENCY PLAN

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SPILL/VOLATILE EMISSIONS RELEASE
CONTINGENCY PLAN
TABLE OF CONTENTS

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SPILL/VOLATILE EMISSIONS RELEASE CONTINGENCY PLAN

The SHSO shall identify potential emergency situations that could arise at a job site and the primary resources for emergency assistance. Site personnel must be prepared to immediately respond to any site emergency. The SHSO shall ensure that all site personnel are familiar with the project plans developed to effectively handle emergency situations.

1.0 RESPONSIBILITIES

In the event of an emergency, the Project Manager (PM) or designee shall be designated as the Emergency Response Coordinator and be responsible for control and decision-making on the site. This individual must:

- Be identifiable to local emergency response personnel.
- Be backed up with a specified alternate.
- Have authority to resolve any safety and health problems with assistance from the SHSO.
- Be authorized to obtain equipment and supplies, as needed.
- Have control of all personnel entering that portion of the site within the emergency area.
- Have an established line of communications to obtain the clear support of contractor management and the technical groups.

1.1 Project Manager

The Project Manager has overall responsibility for the project. He must ensure that adequate staff and resources are available to conduct an effective emergency response program. The PM will be responsible for coordinating and implementing this plan. He shall enforce health and safety requirements at the site. He shall have a working knowledge of federal, state, and local regulations as well as contractor policies and procedures. The PM shall coordinate activities with the Site Health and Safety Officer. In the absence of the PM, the SHSO shall assume his responsibilities.

The PM must be thoroughly familiar with all aspects of the Emergency Response Plan, all operations and activities of the facility, the locations and characteristics of waste handled, the location of all records within the facility, and the facility layout. In addition, this person must have the authority to commit the resources needed to carry out the activities of this plan.

Whenever there is an imminent or actual emergency situation, the Emergency Coordinator, or his designee, must immediately:

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- Activate internal facility alarms or communication system where applicable to notify all facility personnel

- Notify appropriate State or Local agencies with designated response roles if their help is needed

- Identify the characteristics, exact source, amount and extent of any released materials. He may do this with the aid of facility records, and if necessary by chemical analysis

- Concurrently, the PM must assess possible hazards to human health, the environment, and the community that may result from chemical release, fire, or explosion. This assessment must consider both direct and indirect effects caused by the emergency.

The PM must take all reasonable measures necessary to ensure that fires, explosions, and releases do not occur, recur, or spread to other materials at the South Cavalcade Superfund Site. These measures must include, where applicable, stopping processes and operations, collecting and containing released waste, and removing or isolating containers.

If operations are stopped in the response to a fire, explosion or release, the PM must monitor for leaks, pressure buildup, gas generation or ruptures in valves, pipes, or other equipment, wherever appropriate.

Immediately after an emergency, the PM must provide for treating storing, or disposing of recovered materials, impacted soil or surface water, or any other material that results from a release, fire, or explosion.

The PM must ensure that, in the affected area(s):

- No materials that may not be compatible with the released materials is treated, stored, or disposed of until cleanup procedures are completed.

- All emergency equipment listed in this plan are cleaned and fit for its intended use before operations are resumed.

1.2 Health and Safety Manager (HSM)

The HSM is responsible for developing all emergency procedures and components to this Emergency Response Plan. He shall provide technical guidance to the Emergency Coordinator. He shall identify staffing needs and supervise all aspects of the program.

1.3 Site Health and Safety Officer (SHSO)

The SHSO is responsible for implementation of the Health and Safety program at the site. He will coordinate site health and safety

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activities with the emergency coordinator and report technically to the HSM in the event of an emergency.

The SHSO has the authority to:

- Stop work
- Provide necessary personnel monitoring
- Require specific health and safety precautions prior to site entry by personnel
- Require any personnel to obtain immediate medical attention if warranted
- Restrict access to the site or a portion thereof
- Order the immediate evacuation of personnel from any area of the site
- Enforce the Worker Health and Safety Plan (WHSP), Project Instructions and this plan in the absence of the PM.
- Inspect and maintain emergency equipment (e.g., fire extinguisher and self-contained breathing apparatus) at the facility to provide for safe and continuous operation in an efficient and cost-effective manner

1.4 Emergency Response Team

The Emergency Coordinator, SHSO, and other personnel designated and trained by the Emergency Coordinator or SHSO, shall respond at the site in the event of an emergency.

The SHSO shall initiate a detailed fire prevention and protection training program.

Supervisors are responsible for maintaining a constant awareness of the fire potential in their area of responsibility and scheduling specific training for aspects of fire prevention and protection unique to that area.

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2.0 TRAINING AND DRILLS

On-site personnel shall have a specified level of emergency training depending on their job responsibilities.

Emergency training and drills shall be scheduled and conducted for site personnel as authorized by the SHSO and have clear support of contractor management and the technical support groups in the Home Office. On-site businesses will not be participants in the site drills, but will be encouraged to conduct their own drills.

All site personnel, whether directly involved in emergency responses or not, shall be made aware of their responsibilities in an emergency.

Appendix C is a listing of off-site emergency assistance agencies that shall be posted adjacent to strategically located phones and in other conspicuous places on the site.

Visitors shall be briefed on basic emergency procedures (i.e., emergency signals, evacuation routes).

Off-site emergency assistance personnel shall receive site-specific information pertinent to emergency response and should be provided with the following minimal information:

- Potential site-specific hazards
- Site emergency procedures
- Decontamination procedures
- Response techniques

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3.0 TYPES OF EMERGENCIES

A variety of work-related (falls, chemical exposures, heat stress, equipment failures, etc.) and site-related (fires, explosions, releases of vapors, chemical reaction, etc.) emergencies could occur at a site:

- Occupational
  - Personal injury or fatality
  - Property damage
  - Environmental release
  - Personnel exposure
  - Fire
  - Unplanned water discharge
  - Impacted substance spills
- Natural Phenomena
  - Earthquake
  - Tornado/hurricane
  - Snow, ice and wind
- Threats and civil disorders
  - Bomb threat
  - Sabotage/intrusion
  - Civil disturbances (hostile)
  - Kidnapping/extortion
  - Unauthorized entry, vandalism or theft

3.1 Priorities for First Aid, Primary Medical Care and Decontamination

For any life-threatening injury or illness or for any situation where immediate primary medical attention is necessary, medical care shall take precedence over monitoring and/or decontamination. Monitoring and decontamination should be done prior to seeking primary medical care only if they can be accomplished without delaying medical care or adversely impacting the sick or injured person.

3.2 First Aid Assistance

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First aid assistance shall be administered by individuals trained and certified by the American Red Cross or equivalent agency in first aid and CPR. A permanent location shall be set aside, in a clean and safe area, with appropriate first aid provisions for the care of employees in the event of an injury or illness. This area shall then be designated as the point of contact for emergency response personnel when summoned for assistance.

3.3 Minor Occupational Injuries

Minor injuries to employees on site may be treated by individuals utilizing the first aid kits located on site.

3.4 Non-Serious Occupational Injuries

Personnel with non-serious medical injuries that require a physician's attention should be driven to the physician's office noted on the site-specific Emergency Assistance List in the WHSP. If more than one dose of medication is administered, the incident becomes an OSHA reportable.

3.5 Emergency Occupational Injuries

Emergency injuries require that the individuals be stabilized to reduce the possibility of shock, and an ambulance be summoned (Appendix C).

A worker who has been in a impacted work area, should be surveyed prior to ambulance arrival by appropriate contractor personnel. If site-related constituents are detectable above allowable limits on the injured individual, steps to decontaminate the individual should be taken if possible. However, life support techniques will take precedence over decontamination.

Emergency injuries/illnesses will be handled at the hospital listed in the WHSP.

3.6 Occupational Injuries with Contamination

Upon notification of an injury on site, the site SHSO or designated representative shall be summoned to the location of the injured individual to supervise the monitoring and decontamination, if necessary.

Any worker requiring medical attention shall be evacuated promptly from any impacted area. However, personnel should not enter an area to attempt a rescue if their own lives would also be threatened because of inadequate personnel protection (i.e., rescue from oxygen deficient atmosphere without SCBA).

The SHSO shall be responsible for evacuating any person from any controlled area and for providing special decontamination for any injured person.

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Only qualified personnel shall give first aid and stabilize any worker needing assistance. Life support techniques such as cardiopulmonary resuscitation (CPR) and treatment of life-threatening problems, such as bleeding, airway maintenance, and shock shall be given top priority. Professional medical assistance shall be obtained as soon as possible.

Site-related constituent measurements should be taken of the injured individual and the hospital notified prior to the ambulance arrival at the medical facility. If this is not possible, the accident scene should be checked and an estimate of the constituent levels relayed to the medical facility.

Individuals that are impacted by constituents of concern and require emergency treatment will be transported by ambulance to the hospital noted in the WHSP.

3.7 Fire Fighting

An attempt shall be made to extinguish small fires with portable fire extinguishers. Personnel using these devices shall be trained in their use. Fires that cannot be controlled immediately shall be extinguished by the local fire department noted in Appendix C. If a fire is not extinguished with a portable extinguisher, personnel shall immediately evacuate the area.

Any fire, no matter how seemingly insignificant, must be reported to the Emergency Coordinator. A fire that does not appear to be extinguishable shall be reported to the fire/rescue department noted in this document. Primary attention should be focused on rescue of personnel, preventing the spread of fire to other areas, and treatment of injuries.

The Emergency Coordinator, or his designee, will be required to interface with the fire department as it arrives on the scene. He will give all pertinent information including hazards, missing personnel including their last known work location and the fire location and size.

3.8 Impacted Substance Spill

During the Spill - The Emergency Coordinator shall direct emergency activities at the spill and assure that all health and safety equipment and supplies needed for a spill are readily available and properly used.

The members of the Emergency Response Team shall be instructed on the suspected characteristics of spilled material(s) and special clean-up procedures.

The SHSO and Home Office support personnel listed in Appendix C shall be responsible for providing the Emergency Coordinator with technical information.

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Spill Clean-up - During a spill clean-up, the SHSO shall:

- Monitor for chemical or biological exposures
- Determine the need for protective equipment and apparel
- Identify the restricted work areas and controlled access areas
- Provide clean-up guidance

The Emergency Coordinator shall be responsible for directing any subcontractor work crews. The SHSO shall remain at the spill scene during clean-up activities, until the scene is secured or released by the Emergency Coordinator. The SHSO shall notify the HSM at the earliest opportunity of all activities and shall provide technical information to the Emergency Coordinator. The SHSO shall receive technical direction from the HSM.

3.9 Gas, Vapor, and Dust Emission Response Plan

3.9.1 Site Emergency Warning System. Several warning systems may be utilized depending on the work-site conditions, the type and the degree of emergency involved. Among those available and appropriate for this site are

- Verbal communications
- Vehicle horns
- Portable hand-held compressed gas horns
- Telephones
- Two-way radios

3.9.1.1 Verbal Instructions. Verbal instructions with or without assistance are used to deal with specific incidents.

3.9.1.2 Horn Signals. Horn signals are used to signify an emergency warning.

3.9.1.3 Emergency Site Evacuation Signal. One long blast of vehicular or compressed gas horns is used on-site to signify emergency evacuation of the immediate work area to the predetermined rally point (as covered in the daily Health & Safety Briefing), where a head count will be taken and further instructions given.

3.9.1.4 Exclusion Zone Evacuation Signal. Repeated short blasts are used on-site or from off-site to signify evacuation of all personnel from the Exclusion Zone to the hot line where further instructions will be given after a head count is taken.

3.9.2 General Emergency Procedures. In case of an emergency or hazardous situation, the team member that observes this condition shall immediately give the alarm.

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3.9.2.1 Communications Priority. Upon hearing an alarm, all communications will cease and the member giving the alarm will proceed to give the PM, SHSO and/or the BEAZER representative all pertinent information. BEAZER site personnel will be notified.

3.9.2.2 Response Actions. Actions to be taken will be dictated by the emergency.

3.9.2.3 Equipment Shutdown. Power equipment will be shut down and operators will stand by for instruction.

3.9.2.4 Injured Personnel Decontamination. Injured personnel will be, so far as necessary and prudent, processed through the entire Decontamination Process.

3.9.2.5 Rally Point. In case of a fire, explosion and/or hazard alarm, individuals will proceed immediately to the rally point assigned in the Daily Health & Safety briefing.

3.9.2.6 Headcount. Upon arrival at the rally point, a complete head count will be taken by the PM or SHSO and reported to the BEAZER representative. Individuals will stay at the rally point until the area is secured and they are instructed to return to work by the Project Manager.

3.9.3 Flammability. If explosion meter readings above background are encountered, the reading shall be immediately verified and the instrument checked to be sure it is working properly. Any concentration of flammable vapors in excess of ten (10) percent of the lower explosive limit (LEL) at the perimeter of the site shall result in:

1. Stoppage of on-site operations that are producing the flammable vapors

2. Investigation of on-site operations to determine the causation of the flammable vapors

3. Implementation of engineering controls to reduce flammable vapors at the site perimeter to less than five (5) percent of the LEL

Concentrations equal to or greater than 20 (twenty) percent of the LEL shall result in the immediate evacuation of the public within 300 feet of the affected area. The SHSO shall determine when personnel are safe to return and when operations may resume. Table 3-1 defines action levels and specific responses to flammable vapor action levels.

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TABLE 3-1

INSTRUMENT TYPE	INSTRUMENT CERTIFICATION	ACTION LEVEL	RESPONSE TO CONCENTRATIONS ON SITE	RESPONSE TO CONCENTRATIONS OF OFF-SITE OR AT THE SITE PERIMETER
LEL Monitor	Class I Division I Groups A,B,C, & D	Above background but less than 10 percent	1. Frequent monitoring 2. Alert SHSO	1. Frequent Monitoring 2. Alert SHSO
		10 percent to 20 percent of the level	1. Investigation of on-site operations by the SHSO 2. Continue Monitoring 3. Instrument calibration check	1. Stoppage of work 2. Investigation of on-site operations by the SHSO 3. Instrument calibration check 4. Continuous monitoring 5. SHSO approval to resume on-site operations
		20 percent or greater of the level	1. Stoppage of on-site operations affecting the elevated concentrations 2. Implementation of engineering controls 3. Continuous monitoring 4. Resumation of work when LEL is less than 10 percent of LEL	1. Stoppage of on-site operations until the flammable vapors are less than 5 percent of LEL 2. Continuous monitoring 3. Evacuation of public within 300 feet of affected area 4. SHSO approval to resume work

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3.9.4 Vapors, Gases, and Dusts. Toxic vapors, gases, and dusts will be monitored at the perimeter of the work area. Hourly monitoring shall be conducted whenever site-related constituents are detected above background. Figure 3-1 is a flow diagram providing guidance for monitoring rationale. Ambient air constituents concentrations shall not exceed allowable levels listed in 40 CFR Part 50. Constituents not listed in 40 CFR Part 50 shall not exceed one-fiftieth of the permissible exposure limit (PEL) enforced by OSHA. OSHA standards are found in 29 CFR 1910.

Ambient air concentrations of unknown gases and vapors shall not exceed:

1. Ten (10) parts per million (ppm) above background at the perimeter of the work area

2. Five (5) ppm above background at the perimeter of the exclusion zone

Compliance with the above requirements will minimize public exposure to on-site chemicals such as benzene, phenol, and other low threshold compounds that may escape the South Cavalcade Superfund Site.

Whenever ambient air levels exceed criteria stated above, operations shall not resume unless all the following criteria are met:

1. Constituents have been identified and safe levels are not exceeded

2. Engineering controls have been implemented to control airborne emissions to meet criteria stated above

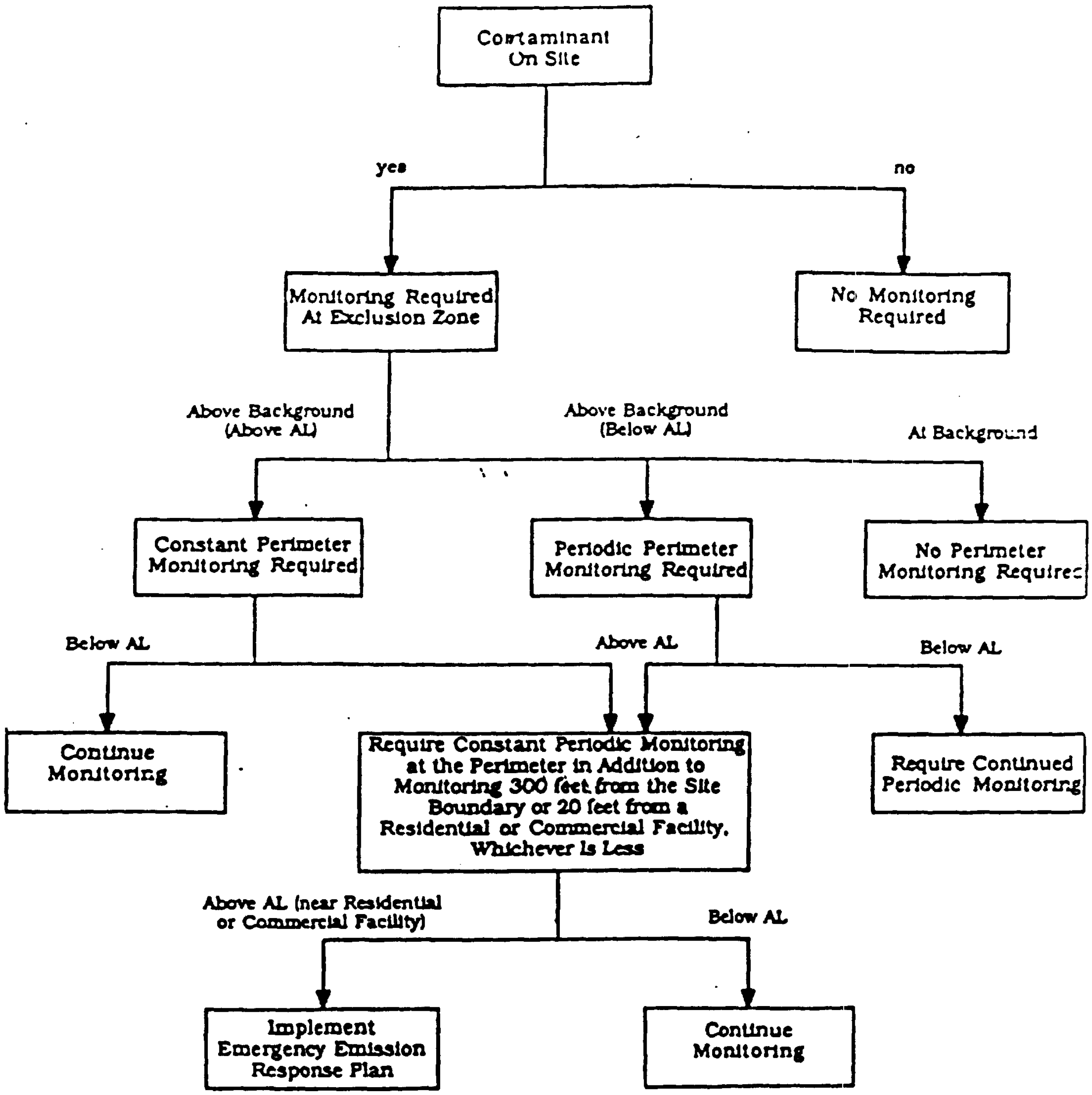
3. The SHSO approves resuming operations after receiving functional guidance

3.9.5 Emergency Emission Response Criteria. The Emergency Emission Response Plan described below shall be implemented whenever any of the following criteria is met:

1. Flammable gases and vapors exceed twenty (20) percent of the LEL within twenty (20) feet of a commercial or residential facility

2. Gases such as hydrogen sulfide or hydrogen cyanide exceed fifty percent of the ambient air standard within twenty (20) feet of commercial or residential facility

FIGURE 3-1



FLOW DIAGRAM PROVIDING GUIDANCE

FOR MONITORING RATIONALE

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3. Unknown gases or vapors exceed five (5) ppm above background at three hundred (300) feet from a commercial or residential facility

4. Unknown gases or vapors exceed one (1) ppm within twenty (20) feet of a commercial or residential facility

5. Known constituents not listed in 40 CFR Part 50 exceed one-fiftieth of the OSHA PEL within twenty (20) feet of a commercial or residential facility

3.9.6 Emergency Emission Response Plan. Upon activation of the emergency, the following activities will be undertaken:

- The local police authorities will immediately be contacted by the SHSO or PM and advised of the situation.

- Evacuation of the public will be conducted at all areas adjacent to and within the impacted zone as defined above.

- Frequent air monitoring will be conducted at 30-minute intervals within the 20-foot zone. If two successive reading below action levels are measured, air monitoring may be halted or modified by the SHSO.

- The following personnel will be notified in the listed sequence in the event that this Major Vapor Emission Response Plan is activated:

Responsible Person	Contact	Phone
(TBD)	Health and Safety Manager	(TBD)
(TBD)	Project Manager	(TBD)

3.10 Natural Phenomena

The Emergency Coordinator and the SHSO are responsible for anticipating as much as possible, any potential emergency situation that can occur.

4.0 SITE CONTROL AND SECURITY (EMERGENCY CONDITIONS)

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In the event of an emergency, the PM shall be responsible for:

- Ascertaining who is on site
- Controlling entry of personnel into the affected area
- Directing emergency rescue and response personnel

5.0 COMMUNICATIONS

5.1 On-site Communications

An on-site communications system (See Section 3.9.1) shall be established to alert workers to danger, convey safety information, and maintain site control. In addition, the Emergency Coordinator will contact any on-site businesses when notification is necessary.

5.2 Off-site Communications

The SHSO shall ensure that all site personnel be familiar with the procedure for contacting public emergency assistance agencies. When reporting an emergency situation, the following information shall be provided:

- Name of person making call
- Telephone number and location of person making call
- Name of person(s) exposed or injured
- Nature of emergency
- Actions taken
- Name and location of site contact for emergency if other than caller

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6.0 EMERGENCY EQUIPMENT AND SUPPLIES

The SHSO shall, with guidance from S&H staff, assure that basic emergency equipment and supplies are available and in good condition at the work site.

7.0 EVACUATION PLAN

An evacuation of any work location may be required because of fire, chemical release, explosive or flammable atmospheres, or other abnormal conditions. The evacuation will continue until normal conditions have been restored and reentry authorized by the Emergency Coordinator. It is important that during an evacuation process, all persons should remain calm and follow prescribed procedures for an orderly exit. The evacuation procedures are described in the following paragraphs.

The SHSO shall make site personnel aware of evacuation routes (primary and alternates). Evacuation should be upwind or crosswind from any airborne constituents of concern. The SHSO shall determine daily a central meeting point based on the wind direction. The meeting will be discussed daily with the site workers. A daily head count shall be made by the SHSO or Emergency Coordinator to determine, should evacuation become necessary, if all site personnel are safety evacuated.

No personnel shall reenter the work site unless to attempt a rescue. Only trained personnel may attempt a rescue. Workers shall not reenter an evacuated area until the emergency conditions have been corrected. The SHSO and Emergency Coordinator will determine when the area is safe for reentry and the Emergency Coordinator shall authorize reentry.

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8.0 REPORTING AND EMERGENCY/COMMUNITY EVACUATION

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If the Emergency Coordinator determines the facility has had a release, fire, or explosion which could threaten human health or the environment outside the facility, he must report his finding as follows:

- If his assessment indicates that evacuation of local areas may be advisable, he must immediately notify appropriate local authorities (emergency phone numbers given in Appendix C). He must be available to help local and other agency officials decide whether areas should be evacuated.

- He must immediately notify either the governmental official designated as the on-scene coordinator for that geographical area (in the applicable regional contingency plan under Part 1510 of the Environmental Protection Agency 40 CFR) or the National Response Center (using their 24-hour toll-free number 800/424-8802). The report must include:

  - Name and telephone number of reporter
  - Name and address of the facility
  - Time and type of incident (e.g., release, fire)
  - Name and quantity of material(s) involved if known
  - The extent of injuries, if any
  - The possible hazards to human health or the environment

- The Project Manager should notify the EPA Regional Administrator and appropriate State and local authorities that all equipment listed in this plan is clean and operational. The Project Manager shall ensure that material which may not be compatible with any released material is not treated, stored or disposed of until cleanup procedures are completed. Operations may be resumed in the affected area(s) only after the emergency condition has been resolved.

- The Project Manager must note in the operating records the time, date, and details of any incident that requires implementing the contingency plan. Within 15 days after the incident, the Project Manager must submit a written report on the incident to the Regional Administrator with a copy to the HSM. The report must include:

  - Name, address, and telephone number of the Project Manager
  - Name, address and telephone number of the facility

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- Date, time and type of incident (e.g., fire, explosion)
- Name and quantity of material(s) involved
- The extent of injuries, if any
- An assessment of actual or potential hazards to human health or the environment, where this is applicable
- Estimated quantity and disposition of recovered material that resulted from the incident

9.0 COPIES OF THE EMERGENCY RESPONSE PLAN

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A copy of the Emergency Response Plan and all revisions to the plan must be:

- Maintained at the facility
- Submitted, as appropriate, to all local police departments, fire departments, hospitals, and State and local emergency response teams that may be called upon to provide emergency services

10.0 ARRANGEMENTS WITH LOCAL AUTHORITIES

Arrangements shall be made to familiarize the police, fire departments, and emergency response teams with the layout of the facility, properties of waste handled and associated hazards, places where on-site personnel would normally be working, entrances to roads inside the facility and possible evacuation routes.

The Hospital shall be familiarized with the properties of waste handled at the facility and the types of injuries or illnesses which could result from fires, explosions, or releases. Documentation of these meetings shall be retained.

Documentation shall be made if a State or local authority declines to provide support during an emergency.

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11.0 AMENDMENTS TO THE EMERGENCY RESPONSE PLAN

The Emergency Response Plan must be reviewed, and immediately amended, if necessary, whenever:

- Applicable regulations are revised
- The plan fails in an emergency
- The facility changes - in its design, construction, operations maintenance, or other circumstances - in a way that materially increases the potential for fires, explosions, or releases of waste or waste constituents, or changes the response necessary in an emergency
- The list of emergency coordinators changes
- The list of emergency equipment changes

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12.0 INVESTIGATION/RECORD KEEPING

The SHSO shall investigate all emergency incidents.

Emergencies shall be investigated by the Health and Safety staff following guidance in the Safety Procedures Manual. The requirements for occupational injury record keeping are also described in this document.

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13.0 EMERGENCY ASSISTANCE AGENCIES AND CONTRACTS

Emergency Telephone Numbers

Police Northeast Substation 5703 Eastex Freeway Main Number	911 or (713) 699-3460 (713) 247-5420
Hospital Lyndon B. Johnson General Hospital 5656 Kelly Street Houston, TX 77026	911 or (713) 636-5000
Fire Department/Ambulance 333 Preston Houston, TX 77002	911 or (713) 247-5000
Texas State Troopers	(713) 681-1761
City Switchboard	(713) 247-1000
Harris County Sheriff	911 or (713) 221-6044
To Report Toxic Chemical and Oil Spills	1-800-424-8802

Health Information Services

Poison Control Center	(713) 654-1701
Tox Line	(301) 496-1131
CHEMTREC (24 hour)	(800) 434-9300

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Project Office Personnel (Contacts)

Project Manager	(TBD)

Beazer East, Inc.

Shannon K. Craig, Program Manager	(412) 227-2684 (work)
	(412) 367-4069 (home)

Beazer Environmental Services, Inc.

Michael P. Helbling, Project Manager	(412) 227-2690 (work)
	(412) 733-4627 (home)

Environmental Protection Agency

Mark Fite, Remediation Project Manager	(214) 655-6715

009704

APPENDIX H

RESPIRATOR INSPECTION, MAINTENANCE, AND STORAGE PROGRAM

009706

RESPIRATOR INSPECTION, MAINTENANCE, AND STORAGE

I. PURPOSE:

To provide guidelines to aid in the development of site respiratory protection programs.

II. SCOPE:

This guide is for use at all site operations.

III. INSPECTION AND MAINTENANCE:

A. General

The OSHA standard requires that the respiratory protection program shall include a maintenance program consisting of at least the following:

1. Inspection for defects (including a leak check).
2. Routine cleaning and disinfecting.
3. Repair and/or replacement as required.
4. Proper and sanitary storage of equipment.

The OSHA standard permits the tailoring of the maintenance program to suit the particular operation and hazards involved. The maintenance programs will include at least the minimum elements given above, with careful consideration to individual respirator manufacturer's instructions for cleaning and maintenance for each respirator type.

B. Cleaning and Disinfecting

1. For operations where reusable respiratory protective equipment is used routinely, respirators shall be cleaned and disinfected daily.

2. For operations where respirators are used less frequently, periodic cleaning and disinfecting may be appropriate if respirators are issued for continuous personal use by an individual worker.

3. A respirator issued for other than continuous personal use by a worker, including routine, non-routine, emergency, or rescue use, shall be cleaned and sanitized after each use.

C. Inspection, Part Replacement, and Repair

1. Each respirator shall be inspected regularly before and after each use.

2. Each respirator shall be inspected by the user immediately prior to each use to ensure that it is in proper working condition.

3. Routinely used air-purifying respirators should be checked as follows before and after each use:

   (a) Examine the facepiece for:

      (1) Excessive dirt.

      (2) Cracks, tears, holes or physical distortion of shape from improper storage.

      (3) Inflexibility of rubber facepiece (stretch and knead to restore flexibility.)

      (4) Cracked or badly scratched lenses in full facepieces.

      (5) Incorrectly mounted full facepiece lenses, or broken or missing mounting clips.

      (6) Cracked or broken air-purifying element holder(s), badly worn threads or missing gasket(s) if required.

   (b) Examine the head straps or head harness for:

      (1) Breaks.

      (2) Loss of elasticity.

      (3) Broken or malfunctioning buckles and attachments.

      (4) Excessively worn serrations on head harness, which might permit slippage (full facepieces only).

   (c) Examine the exhalation valve for the following after removing its cover:

      (1) Foreign material, such as detergent residue, dust particles or human hair under the valve seat.

      (2) Cracks, tears or distortion in the valve material.

(3) Improper insertion of the valve body in the facepiece.

(4) Cracks, breaks or chips in the valve body, particularly in the sealing surface.

(5) Missing or defective valve cover.

(6) Improper installation of the valve in the valve body.

(d) Examine the air-purifying element for:

(1) Incorrect cartridge, canister or filter for the hazard.

(2) Incorrect installation, loose connections, missing or worn gasket or cross threading in the holder.

(3) Expired shelf-life date on the cartridge or canister.

(4) Cracks or dents in the outside case of the filter, cartridge or canister, indicated by the absence of sealing material, tape, foil, etc., over the inlet.

(e) If the device has a corrugated breathing tube, examine it for:

(1) Broken or missing end connectors.

(2) Missing or loose hose clamps.

(3) Deterioration, determined by stretching the tube and looking for cracks.

(f) Examine the harness of a front - or back-mounted gas mask for:

(1) Damage or wear to the canister holder, which may prevent its bein g held in place.

(2) Broken harness straps for fastening.

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4. <u>Inspection of a Routinely Used Air-Supplied Device</u> 009709

(a) If the device is a tight-fitted facepiece, use the procedures outlined under air-purifying respirators, except those pertaining to the air-purifying elements.

(b) If the device is a hood, helmet, blouse or full suit, use the following procedures:

(1) Examine the hood, blouse or full suit for rips and tears, seam integrity, etc.

(2) Examine the protective headgear, if required, for general condition with emphasis on the suspension inside the headgear.

(3) Examine the protective face shield, if any, for cracks or breaks or impaired vision.

(4) Make sure the protective screen is intact and secured correctly over the face shield of abrasive blasting hoods and blouses.

(c) Examine the air supply system for:

(1) Integrity and good condition of air supply lines and hoses, including attachment and end fittings.

(2) Correct operation and condition of all regulators, or other air flow regulators.

5. <u>For SCBA units</u>, the inspection should include all items in Section D above, and should determine that:

(a) The high pressure cylinder of compressed air or oxygen is sufficiently charged for the intended use, preferably fully charged.

(b) On closed circuit SCBA, a fresh canister of CO_2 (carbon dioxide) sorbent is installed.

(c) On open circuit SCBA, the cylinder has been recharged if less than 25% of the useful service time remains.

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D. Storage.

(a) Respirators shall be stored in a manner that will protect them against dust, sunlight, heat, extreme cold, excessive moisture, or damaging chemicals.

(b) Respirators shall be stored to prevent distortion of rubber or other elastomeric parts. They shall not be stored in such places as lockers and tool boxes unless they are protected from contamination, distortion, and damage.

(c) Emergency and rescue-use respirators that are placed in work areas shall be quickly accessible at all times, and the storage cabinet or container in which they are stored shall be clearly marked.

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PERMITTING REQUIREMENTS PLAN

REMEDIAL DESIGN WORK PLAN
SOUTH CAVALCADE SITE
HOUSTON, TEXAS

Prepared for:

BEAZER EAST, INC.
436 SEVENTH AVENUE
SUITE 1450
PITTSBURGH, PA 15219

Prepared by:

BECHTEL ENVIRONMENTAL, INC.
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P.O. BOX 2166
HOUSTON, TX 77252-2166

MARCH 1992

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SOUTH CAVALCADE SITE

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PERMITTING PLAN

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PERMITTING PLAN

1.0 INTRODUCTION

A Remedial Design Work Plan was prepared to describe the pilot plant and construction activities of the remedial action specified in the Record of Decision (ROD) for the South Cavalcade Site in Houston, Texas. A Permitting Requirements Plan is required as part of the Remedial Design Work Plan, pursuant to the Consent Decree between Beazer East, Inc. (Beazer) and the United States Environmental Protection Agency (EPA). In addition to this Permitting Requirements Plan, the Work Plan is comprised of a scope of work, a Quality Assurance Project Plan (QAPP), Sampling and Analysis Plan (SAP), a Health and Safety Plan (HASP) and a Treatability Work Plan. All site activities will be performed according to the procedures described in these plans.

2.0 PERMITTING REQUIREMENTS

Most aspects of the on site remedial action occurring on the South Cavalcade Site do not require permits as remedial action was selected and will be carried out in compliance with Section 121 of CERCLA. Since waste-water and storm water will be discharged offsite, an NPDES permit will be required from the U.S. Environmental Protection Agency and an Industrial Waste Discharge permit will be required from the Texas Water Commission. Also, groundwater withdrawal wells within Harris and Galveston Counties require notification to the Harris-Galveston Coastal Subsidence District. Such wells will be used during the remedial action phase of the project.

Water quality sampling wells are exempt from metering requirements. Applicable or Relevant and Appropriate Requirements (ARARs) will be considered during each phase of remedial action implementation. This plan specifically addresses permits required at the pilot plant stage of the Remedial Design Work Plan.

2.1 Operating Permits

Treated pilot plant waste-water and storm water collected from the pilot plant area will be transferred via a storm water pipe to Little Whiteoak Bayou, a small off-site stream southeast of the site. Since the discharge occurs off site, it is subject to federal and state permitting requirements under existing regulations. At the current time, Texas is not authorized to issue waste water discharge permits under the Clean Water Act. Instead, Texas developed an industrial waste water discharge

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permit program. A National Pollutant Discharge Elimination System (NPDES) permit will be required by the U.S. Environmental Protection Agency (EPA) under the authority of Section 402 of the Clean Water Act. In addition, an industrial waste water discharge permit will be required from the Texas Water Commission (TWC) under Texas Administrative Code, Title 31. Also, notification of the intent to drill wells used to withdraw water from the shallow aquifer during the remedial action phase of the operation will be submitted to the Harris-Galveston Coastal Subsidence District. Actual permits for the wells are not required according to the legal staff of this district, although applications should be forwarded to the district in order to confirm this opinion.

The preparation of these permit applications or notifications will occur concurrently with the remedial design activities of the South Cavalcade Site. Permits for the pilot test phase of the project will be required prior to construction of the pilot plant at the site. The NPDES permit and the TWC industrial waste water discharge permit will require modification when the design and site configuration aspects for the remediation treatment phase of the project has been finalized. Permit application activities for the pilot test phase of the project have been identified as follows:

2.1.1 NPDES Permit Requirements

- Organizational details of the operating entity.
- Description of the processes involved in the production of waste water in the facility.
- Line drawings of the processes involved in the operation of the pilot plant.
- Quality of background water in terms of standard pollutants, such as pH, total suspended solids and BOD_5 may be required.
- Estimated effluent quantity and quality in terms of heavy metals, organic constituents, and pesticides must be listed.
- As outlined in the Clean Water Act, a 401(1) (1) Water Quality Certification from the Texas Water Commission, indicating that this waste water will not cause the violation of existing stream standards and is in compliance with

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technology-based treatment standards will be required for the NPDES permit application.

2.1.2 TWC Discharge Permit Requirements

- Discuss permitting requirements with TWC Permit engineers (if necessary).

- Organizational details of the operating entity.

- Description of the processes and sources involved in the production and treatment of waste water and storm water in the pilot plant.

- Quality of background water in terms of standard pollutants, such as pH, total suspended solids and BOD_5 may be required.

- Estimated effluent quantity and quality (believed present/absent) in terms of heavy metals, organic constituents, and pesticides resulting from the construction and operation of the pilot plant must be listed in the application. Characteristics of the storm water, to be discharged from the same outfall as the pilot plant discharge must also be included in the application (see Tables 4 and 6 in the TWC application for constituents to be considered).

- Ground level photographs of the site.

- Effluent disposal path description and discharge point location in terms of latitude and longitude.

- Physical characteristics of the receiving water body during normal dry weather, including flow and velocity measurements and stream widths (4 to 10 transepts required over a 0.5 mile length, depending upon width and habitat variability).

- Downstream uses and accessibility of the receiving water body (Little Whiteoak Bayou).

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- Other receiving water body characteristics, including drainage area, flow fluctuations, stream bends, average bank erosion, percentage instream cover, and width and composition of riparian vegetation.

- Location map on 7.5 minute scale including site, tract boundaries and discharge point.

- Plot plan of facility showing treatment facility location, maintenance areas, etc.

- Location map showing surrounding land use, including nearby residential areas, other waste disposal locations and 100-year frequency flood level, at the site.

- Names and addresses of persons owning adjacent properties at least one mile downstream from the proposed point of discharge to the storm drain on site.

- Proof of contact with and attempts to obtain approval from any entity owning a drainage ditch or conveyance to be used to carry the treated waste water.

- General nature of the business and SIC code.

- Local rainfall data.

- Public notification in a local newspaper and signs at the site.

2.1.3 <u>Harris-Galveston Coastal Subsidence District</u>

- Since the wells being constructed are strictly for use during remediation of a CERCLA site, permits for the wells may not be required. However, notification by letter is encouraged out of courtesy.

- Subsidence district regulations indicate that some wells are exempt from permitting requirements while others are exempt from water metering. Water quality monitoring wells are in the

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latter category and no mention is made of exemptions for wells for the remediation of CERCLA sites.

- Discussions with the legal staff of the Subsidence District have revealed that a letter indicating activities at the site with regard to the remedial action wells would be in order. This letter should be sent prior to construction of the pilot plant phase at the site. Since little effort would be required to complete an application for each well, it is recommended that a permit application be completed and submitted for each well.

2.1.4 Effluent Characterization Data

Data regarding effluent characterization in terms of pollutants and volume will be determined during the field investigation phase of the remedial design work. Analysis is expected to require four to six weeks from the date of collection. Upon receipt of analytical results, comparisons to influent and projected effluent parameters will be made after application of the projected treatment efficiencies. In addition, the quality and quantity of affected storm water will be projected and the need for treatment will be determined. This treated effluent and storm water data, along with other required information, will be used in the NPDES and TWC discharge permit applications.

2.2 ARARs Considerations

ARARs identified in the Feasibility Study and the ROD will be reevaluated at the pilot plant stage to ensure compliance with applicable or relevant and appropriate requirements.

2.3 Other Considerations

Environmental requirements promulgated during the design or construction phase of this project will be evaluated by the engineer and Beazer and considered for their appropriateness to this project. These include changes in stream standards, spill control regulations, storm water control and treatment standards. The final discharge permit applications for the construction and operation of the remedial design phases of this project will be the same permit applications as used for the pilot plant discharge described but will be modified based on final design and site configuration.

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3.0 SUMMARY

As work progresses on the remedial action activities at the South Cavalcade site, permitting needs and ARARs will be evaluated. TWC and EPA will be notified of considerations or ARARs which may be identified as applicable during site activities, provided they were not identified in the ROD, Feasibility Study, or Remedial Design Work Plan.

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COMMUNITY RELATIONS PLAN

for

SOUTH CAVALCADE SITE
HOUSTON, TEXAS

Prepared for:

BEAZER EAST, INC.
436 SEVENTH AVENUE
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MARCH 1992

COMMUNITY RELATIONS PLAN
FOR THE
SOUTH CAVALCADE SITE

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Community Relations Plan
for the
South Cavalcade Site

OBJECTIVES

This plan outlines the efforts which will be made to inform the public of activities and decisions made concerning the Remedial Design and Remedial Action at the South Cavalcade Site. Specifically, the plan will endeavor to:

- Give the public the opportunity to comment on and provide input to technical decisions

- Inform the public of planned or ongoing actions

- Focus and resolve conflict

SITE BACKGROUND

The South Cavalcade site is located in the northern section of Houston, Texas. The site occupies approximately 66 acres forming a rectangular shaped area with the longest dimension oriented north to south. The eastern and western boundaries of the site are formed by railroad tracks owned by Houston Belt & Terminal (HB&T). The northern edge of the property is bounded by Cavalcade Street and the southern border runs along Collingsworth Street. (See Figure 1.1)

Within the site, the area consists of Baptist Foundation of Texas (Northwest Transport, Inc.) in the northern end, a large undeveloped portion of land occupying the central region, and Merchants Fast Motor Lines (Trucking Properties, Inc.) and Palletized Trucking, Inc. in the southern end. The three businesses are all trucking companies.

History and Description

In 1910, the National Lumber and Creosoting Company acquired ownership of approximately 55 acres to build and operate a wood treating facility. National Lumber and Creosoting Company operated the site until 1938 when they were acquired by the Wood Preserving Corporation, a subsidiary of Koppers Company. The facilities on the site consisted of: Several buildings which housed wood treating processing equipment and offices; railroad tracks on the northern and southern ends; coal tar operations and storage tanks; extensive lumber storage yards and two wastewater spray ponds. Based on 1938 aerial photographs, processing operations, including treating cylinders, work tanks, drip tracks, and spray ponds, were

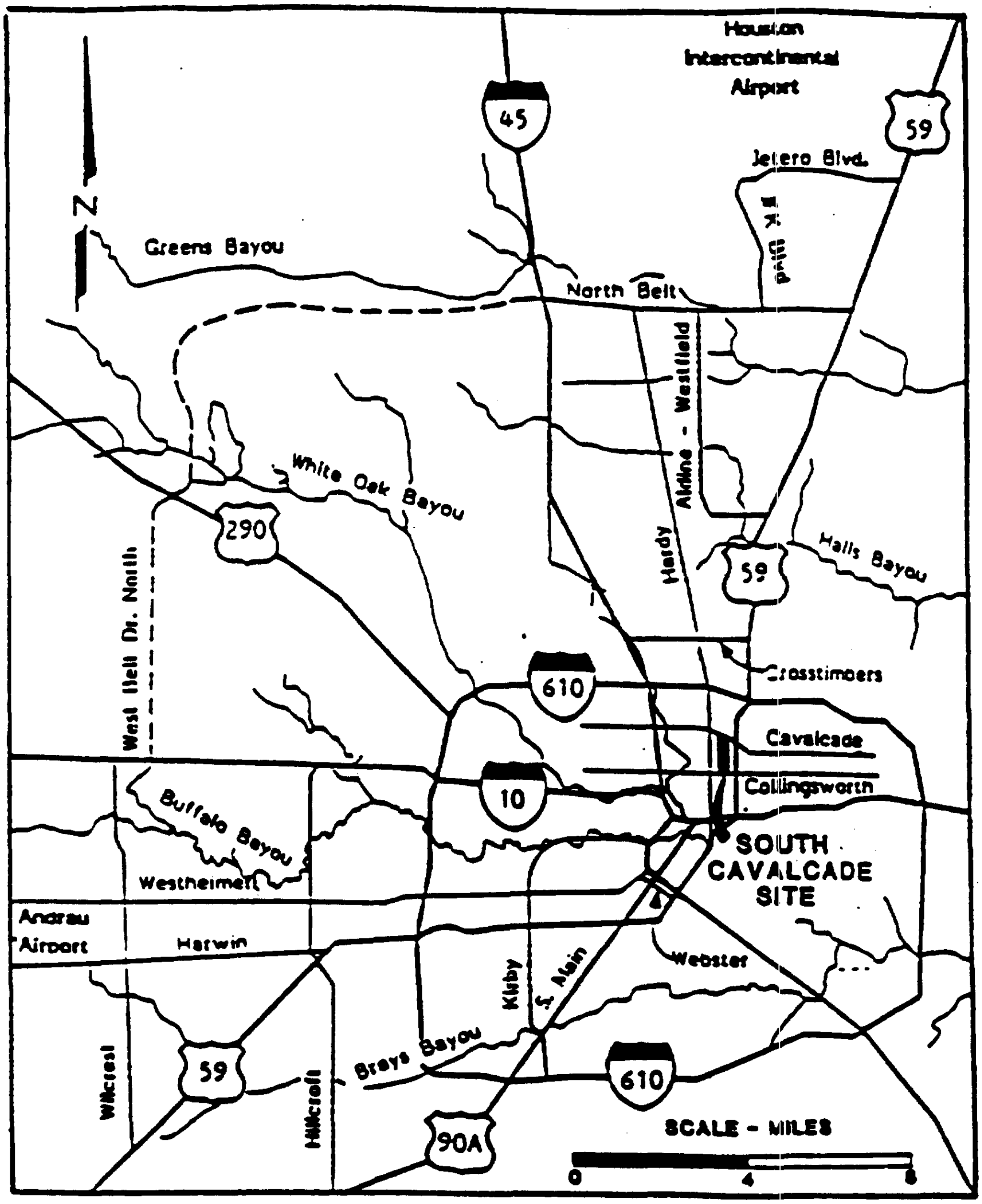

Fig. 1.1 Site Location Map

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conducted along the southern portions of the site while storage of treated and untreated lumber was in the northern and middle sections of the site.

In 1940, the Wood Preserving Corporation was merged into Koppers Company. In 1944, Koppers Company incorporated and became Koppers Company, Inc. Records indicate that the site was operated as a wood treating and coal tar distillation facility until November 1962, when the plant was dismantled and the property was sold to Merchants Fast Motor Lines, Inc.

On December 31, 1962, Merchants Fast Motor Lines sold the 55-acre tract to Mr. Gene Whitehead who also purchased an additional 12+ acres. Mr. Whitehead then subdivided the property and sold portions to the following current property owners:

Current Owner	Purchase Date	Acres
Merchants Fast Motor Lines, Inc. (Trucking Properties, Inc.)	4/02/69	8.5
Palletized Trucking, Inc.	10/26/77	10.3
Baptist Foundation of Texas (Northwest Transport, Inc.)	11/06/69	22.5

A survey was conducted in 1983 to evaluate the suitability of the site for use as a METRO maintenance yard and transit station. Results from the study indicated the potential for localized areas of affected soils and groundwater.

As a result of this survey, the site was referred to the Texas Department of Water Resources (TDWR). On April 16, 1984, the TDWR recommended to the EPA Region VI that the South Cavalcade Site be placed on the updated National Priorities List. On March 28, 1985, Koppers Company, Inc., entered into an Administrative Order on Consent with the EPA, Region VI in which it agreed to conduct a Remedial Investigation/Feasibility Study (RI/FS). In 1985, the RI/FS was initiated for the South Cavalcade site and completed in mid-1988. The Record of Decision (ROD) was signed by the EPA on September 26 of that same year.

There was a change in the ownership of Koppers Company, Inc., during 1988. As of June 30, 1988, BNS Acquisitions, Inc. ("BNS Acquisitions"), a Delaware Corporation, and an indirect wholly-owned subsidiary of Beazer PLC, acquired indirectly more than 90% of the outstanding command stock of Koppers Company, Inc. ("Koppers") and on November 14, 1988, acquired indirectly the balance of the common shares. On January 20, 1989, BNS Acquisitions merged into Koppers, and on January 26, 1989, the name of Koppers was changed to Beazer Materials and Services, Inc.

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("BM&S"). On April 16, 1990, BM&S changed its name to Beazer East, Inc. (Beazer).

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SUMMARY OF REMEDIAL INVESTIGATION

The remedial investigation gathered environmental information to define the nature and extent of the potential constituents of concerns at the site and provided the basis for an engineering evaluation of the most feasible methods of remediating the site. Particular attention was devoted to the identification of possible site related constituents migrating from the site which could potentially endanger public health.

Nature and Extent of Problem

Current and past operations on this site have impacted the soils and the upper aquifer and intermediate discontinuous zone by polynuclear aromatic hydrocarbons (PAHs), metals, and volatile organic compounds (VOCs).

Soils

During the RI, four general areas were found to have elevated concentrations of residual organics. Further analytical testing revealed that PAH levels in those areas were responsible for the high organic reading.

Since site related constituents were found in the surface (0 - 0.5 ft.) and surficial (0.5 - 6.0 ft.) soils, the top six feet of soil in the four areas may require remediation.

Groundwater

Groundwater sampling during the RI indicated elevated concentrations of site related constituents in the shallow aquifer (approximately 6 to 20 feet below grade). The majority of compounds found were PAHs. Elevated levels of these constituents were also found in the intermediate discontinuous sand lenses (approximately 50 feet below grade). Two areas of affected groundwater exist at the South Cavalcade site as defined in the RI; one in the southern portion and one in the northern portion of the site.

No detectable levels of any of these constituents were found in deep monitoring wells.

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Air Quality

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An air quality investigation found that air constituents at the site were well below the permissible levels established by EPA.

SUMMARY OF RECORD OF DECISION

The ROD states that soil remediation using a combination of soil washing and in situ soil flushing, and groundwater remediation using physical/chemical separation followed by pressure filtration and activated carbon adsorption can best satisfy the statutory selection criteria.

Soils from the area located in the southeast corner of the site will be excavated and washed. The washed soils will then be returned to the previously excavated areas. These areas will then be capped for soil stability.

In the areas of the north and south ends of the site to be remediated by soil flushing, constituents will be flushed into the upper water bearing layer where they will be extracted with the groundwater.

During the design phase, sampling will be done to more fully define the areas to be remediated by soil washing and soil flushing.

Groundwater will be extracted from the upper aquifer and discontinuous zone, treated, and reinjected in a series of groundwater extraction lines and injection lines in the southern part of the site, and at least one extraction line and one injection line in the northern part. The extraction lines will be situated so that they intercept to the maximum extent possible the affected groundwater before it flows from the site. Treated water will be reinjected.

Groundwater may need to be processed several times to recover and treat the non-aqueous phase. Groundwater collection will continue until the constituents in the groundwater have been recovered to the maximum extent possible. This point will be determined during the Remedial Action based on annual sampling of the groundwater. After this point has been reached, any remaining constituents will be allowed to naturally attenuate to background levels.

Additionally, the ROD allows for in situ biological treatment of soil and groundwater if it can be demonstrated and EPA determines that this process can be implemented and operated at an efficiency equal to or better than the method outlined above.

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SUMMARY OF REMEDIAL DESIGN

The Remedial Design will be accomplished in two phases. The first will be a series of site investigations and pilot tests to establish the design criteria followed by the second phase which will be the actual remedial design (RD).

Design Criteria

A series of investigations and pilot tests will be performed at the South Cavalcade Site to establish the design criteria which will be in the RD. Work will include:

- Soil sampling to determine areal limits of site related constituents above the action level defined in ROD.
- Pump testing of wells drilled on site to determine the well spacing requirements, the volume and quality of the recoverable groundwater.
- Pilot testing of soil flushing agents and techniques using a trench drain. This test may also involve the use of biological agents.
- Pilot testing of soil washing equipment and methods using soil excavated from the southeast corner of the site.
- Pilot testing of water treatment equipment using water collected from the pump testing, the soil flushing, and the soil washing tests.

The site activities are expected to start approximately 8 months after the entry of the Consent Decree and be completed in approximately 26 months.

Remedial Design

When the design criteria has been established by the pilot testing, the design of the remedial work will continue. This design will produce detailed plans and specifications for remedial actions to accomplish the requirements of the ROD. It will be reviewed by the EPA at the 30%, 60%, 90%, and 100% levels of completion and must be approved by the EPA prior to start of Remedial Action. It is anticipated that the Remedial Design phase will be completed in approximately 12 months.

SUMMARY OF REMEDIAL ACTION

The Remedial Action phase will follow approximately 7 months after the approval of the Remedial Design phase. Site work may include the following:

- Mobilization and installation of soil washing equipment
- Mobilization and installation of water treatment equipment and storage tanks
- Installation of injection and extraction wells
- Installation of soil flushing facilities
- Excavation, washing and replacement of washed soils
- Capping of washed soils

It is anticipated the installation of site facilities and soil washing, replacement and capping work will be completed within 60 months. The extraction, treatment, and reinjection of groundwater and the operation of soil flushing facilities may, however, continue beyond this time period.

PROXIMITY AND SIZE OF AFFECTED POPULATION

The 1980 U.S. Census indicates that 9,550 people live within one-half mile of the site. MTA's contaminant survey tested existing off-site industrial and municipal groundwater wells near the South Cavalcade sites and found no constituents of concern which could be attributed to the sites. The closest city of Houston public water supply well is located about 3,100 ft. east of the site.

COMMUNITY INVOLVEMENT AT THE SITE

Reported citizen concern regarding these sites has been minimal. At this time, no known public interest groups or adjacent residents have expressed concern or raised questions about the site. Media coverage of the sites' NPL status was also limited: one or two articles appeared in September 1984 issues of the Houston Chronicle referring to Representative Florio's (D-N.J.) announcement that EPA proposed to include the sites on the updated NPL.

The South Cavalcade site is located in an area that is prone to flooding. Considerable public concern was generated in December 1984 when chemicals were deposited on residents' properties from flooding that occurred in areas a few miles east of the site. Residents near the Cavalcade site have not, to date, expressed concern about flooding from the property; however, local officials

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are concerned that residents and their families be informed in advance of the potential for exposure to constituents on or near the sites.

A press release was sent out and Open House held concerning the RI/FS in September of 1985.

Fact sheets concerning this site have been published by the EPA in November, 1990 and May, 1991. An open house was held in August, 1988 prior to the Record of Decision being published in September of 1988.

COMMUNITY RELATIONS TECHNIQUES AND ACTIVITIES

The following methods will be used to achieve the goals of this Community Relations Plan during the Remedial Action:

Press Release/Fact Sheet: Beazer will distribute a press release/fact sheet to local news publications prior to the start of activities to announce both the start of site activities and give notice of a public Open House to be held to describe the upcoming activities and answer questions.

Briefings for State, County, and Local Officials: The Mayor of Houston, Harris County, Precinct 1 Commissioner and District Engineer will be briefed on the details of the site activities, design schedule, and contingency plans to inform them as to the rationale and appropriateness of the design work and answer any questions they may have. A USEPA representative may be present at all briefings.

Public Open House: An Open House will be held prior to on-site work to explain the site activities to the general public and answer any questions they may have, and workshops will be held periodically at milestones during the Remedial Action. A USEPA representative may be present at the Open House/Workshop.

Newsletter: During both the Remedial Design and Remedial Action, Beazer East, Inc. will publish and distribute an informal newsletter describing site activities and announcing significant milestones. The following disclaimer will be included on all releases, newsletters, and fact sheets: "The United States Environmental Protection Agency (EPA) and South Cavalcade Potentially Responsible Parties (PRPs) are separate entities. This publication was prepared by Beazer East, Inc. who is solely responsible for its contents".

Public Information Repositories: Local access to project documents will be provided by maintaining files of the pertinent documents in

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local libraries and public offices. Copies will be sent to the following locations:

Houston Central Library
Government Documents Area
500 McKinney
Houston, Texas 77002
(713) 236-1313
Monday - Friday 9 a.m. to 9 p.m.
Saturday 9 a.m. to 6 p.m.
Sunday 2 p.m. to 6 p.m.

Houston-Galveston Area Council
3555 Timmons
Suite 500
P.O. Box 2277
Houston, Texas 77227
(713) 627-3200
Monday - Friday 8 a.m. to 6 p.m.

City of Houston
City Secretary's Office
910 Bagby
Houston, Texas 77002
(713) 247-1000
Monday - Friday 8 a.m. - 5 p.m.

Environmental Protection Agency
Region 6 Library
1445 Ross Avenue, Suite 1200
Dallas, Texas 75202-2733
(214) 655-6444
Monday - Friday 8 a.m. - 4:30 p.m.

Texas Water Commission
Stephen F. Austin Building
1700 North Congress Avenue
Austin, Texas 78711-3087
(512) 463-7830
Monday - Friday 8 a.m. - 5 p.m.

The following disclaimer will be included on all releases, newsletters, and fact sheets:

"The United States Environmental Protection Agency (EPA) and South Cavalcade Potentially Responsible Parties (PRPs) are separate entities. This publication was prepared by Beazer East, Inc., who is soley responsible for its contents".

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SCHEDULE OF COMMUNITY RELATIONS ACTIVITIES

The Community Relations Activities are scheduled to be performed as follows. The schedule will be based on the effective date of entering the Consent Decree.

Time After Entering the Consent Decree	Event
240 days	Press release and fact sheet announcing start of site activities
240 days	Brief local officials
240 days	Open House
42½ months	Press release and fact sheet explaining the Remedial Design
As required during the Remedial Design and Remedial Action	Informal newsletters/workshops describing activities and announcing significant milestones

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PROJECT MILESTONES

The following milestones are anticipated during the Remedial Design and Remedial Action phases of the project:

Months after entering the Consent Decree	Event
1 month	Submit Remedial Design Work Plan (RDWP)
7 months	Issuance of NPDES Permit
6 ½ months	EPA approval of RDWP
7 ½ months	Start field work for Site Investigation
26 months	Complete field work
33½ months	EPA approval of pilot study reports
26 months	Start Remedial Design
37 months	EPA approval of Remedial Design
37 months	Submit Remedial Action Plan (RAP)
41½ months	EPA approval of RAP
42 months	Start Remedial Action
105 months	EPA acceptance of RA
108 months	Submit Remedial Action Report
116 months	EPA approval of Remedial Action Report
118 Months	Issue Certificate of Completion

MAILING LIST FOR FACT SHEET

In addition to local officials listed above and the repositories shown, the following list of individuals will receive the fact sheet.

(Attachment A, Mailing List to be provided by EPA)